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THE EARLY RECOGNITION AND TREATMENT OF CERVICAL CANCER

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THERE is a rather general feeling that the present day treatment of cancer, with surgery and radiotherapy as the chief agencies, is not the treatment of the future. This feeling is based on the hope that sooner or later, whether in the near or distant future, some more direct and effective, perhaps even specific, means of combating cancer will be evolved. For the present, however, no other weapons are available to our hands, inadequate and disappointing as they so often are.

In so far as the treatment of cancer of the cervix is concerned, surgery has been all but abandoned in favor of radiotherapy. The reason for this is simple enough, viz.: in comparable groups of cases the percentage of cures obtainable by efficient radiotherapy is just as good as that following competent surgery, while the latter carries with it an inevitable and considerable mortality rate not observed with the proper use of radium. Even before the advent of radium the cry was constantly being heard that surgery had reached its limit in the radical treatment of cervical cancer, and this lament seems even in retrospect to have been fully justified when one considers the magnitude of such procedures as the radical Wertheim operation. Now one is beginning to hear that not a great deal more can be expected from the further development of radiotherapy, although refinements in technique are still being made, with the hope of improving results a little here and there.

What other lines of attack are open to us against this most dreaded of human scourges? The search for the cause or causes of cancer, or, as we now believe, the group of cancer diseases, must and of course will go on, but no one can tell when the solution will come or whether it will carry with it the suggestion for successful treatment, any more than we can feel sure that a highly effective treatment may not be discovered long before we know the etiology of cancer.

The one conclusion always reached by every student of cancer statistics, the conclusion expressed so frequently that it seems almost hackneyed to repeat it again, is that the factor which, far more often than any other, decides the fate of the patient, is the stage at which the proper treatment is begun. On this conviction are based all our efforts to educate the laity and the profession. With the public we are concerned chiefly with instruction as to the possible significance of premonitory and early symptoms and lesions. With the members of our own profession, who are supposedly familiar with these things, we preach

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alertness, conscientiousness, and thoroughness, we try to instruct them as to the characteristics of lesions which should put them on their guard, and we urge them to lose no time in having doubtful and suspicious cases authoritatively decided and proper treatment instituted.

After all, however, doctors are people, and not all are responsive to exhortations and instructions of this sort. Reams have been written on this subject, but every gynecologist of experience can testify that within the ranks of our own profession there is still open to us a real opportunity for improvement, and one for whose existence there is less excuse than for the corresponding and perhaps larger field of possibilities which concerns the public generally. It is really a harsh commentary on our profession, after all our campaigns of public instruction on cancer, that patients who, either by accident or through their own intelligence or alertness, come under medical supervision may still lose their chance because the physician falls down on the job.

What is early cancer? The term early, as applied to cancer of the cervix, is a very relative one. For practical purposes, it would be an enormous advance if the majority of cancer patients could be given the benefits of proper treatment at a stage when the cancer is confined to one lip of the cervix, when it measures not more than a centimeter or so in diameter, when there is no infiltration of the broad ligaments, and when the uterus is freely movable. If all physicians could be trained to recognize cancer in these early stages, an enormous stride forward would have been made, and perhaps this is the immediate goal we should set for men in general practice.

No physician who takes the time and trouble to inspect and palpate the cervix—unfortunately there are still some who do not—can fail to diagnose an advanced cancer. Even the painstaking man, however, may overlook the earlier lesions for the simple reason that his mental image of cancer is that of the late stages—the cauliflower-like growth, the necrotic ulcer, or the very hard, stony and irregularly enlarged cervix. The message for this man must be that the appearance of early cancer is not at all like that which he pictures, and that cancer must be suspected even though there is no large vegetative growth and no large ulcer, if, for example, the cervix presents an unusually hard area, with usually slight superficial ulceration, or if it is the seat of a finely vegetative and usually rather firm excrescence, with bleeding on slight touch.

He must also understand that such lesions may be so inconspicuous that they are missed on any but the most careful examination, including not only palpation but also inspection in the best possible light. He must, in short, develop the habit of going through each cervix with a fine tooth comb, and, what is just as important, making sure that every doubtful case is definitely decided. For not only he, but also the most expert gynecologist will find cases in which clinical methods can not make the diagnosis without the aid of the microscope. But it is this group, in which both the patient and the doctor must go to considerable trouble to make the diagnosis, which will yield the largest proportion of cures.

The general practitioner who encounters the combination of suspicious symptoms and a suspicious cervix, or who finds a suspicious cervix even without symptoms in the course of a pelvic examination, owes it to his patient to have the diagnosis authoritatively decided, as it can be in almost every case. It is no disparagement to say that he is himself rarely qualified to do this, since the decision in such cases depends on a properly performed biopsy and a correct pathological interpretation. He will usually wish to transfer this responsibility to the gynecologist trained in such procedure. But if he is thorough and conscientious he will not rest until the suspicion is confirmed or disproved, rather than merely hope that cancer does not exist, or wait until the clinical diagnosis is plainly evident, with the loss too frequently of the patient's chance for cure.

The contribution, therefore, which can be made to the cancer campaign by the rank and file of our profession is to develop habits of thoroughness in the examination of cervices, especially of those in women beyond thirty, and of course of those who have observed any abnormal bleeding or discharge; to study such

cervices intensively with an eye to the pictures which suggest the possibility or the probability of early cancer; to blot out from their minds the concept of cancer as a cauliflower-like growth or an excavated ulcer; to pursue the diagnosis of every doubtful case unremittingly to a decision; and then to see that proper treatment is begun. As someone has said, it is the man who has cancer "on the brain" who is most likely to uncover cases of this disease.

All this may sound rather utopian, but it represents an avenue of attack richer in immediate possibilities than any other except the education of the public itself. In this connection one other important function of the medical adviser, and also of the gynecologist, should be to carry on an individual cancer educational program of his own, with the individual patients who consult him, perhaps for other reasons. In no other way can the patient be put on her guard in her future more decisively and perhaps so reassuringly than by such a prophylactic consultation with a sensible and intelligent medical adviser.

The earliest stages of cancer. The particular problem to be discussed in this paper, however, has to deal with the diagnosis of even earlier lesions, lesions which perhaps in the present state of our knowledge we are justified in speaking of as the earliest stages of cancer. The problem therefore is one which concerns the specialist—the gynecologist and the pathologist—rather than the general practitioner, for the final decision in such cases must be made by the microscope, which could almost be dispensed with in the more advanced cases.

From cases in which the gross characteristics of the lesion make the diagnosis reasonably certain, to those in which a mere glance through the low power of the microscope reveals the indubitably malignant nature of the lesion, we are now passing to a stage—a high-power stage—in which careful study of the individual cell characteristics must be invoked, with diagnostic decisions which can not always be so definite or so unanimous as in the outspoken forms of the disease. And yet it is in these earliest stages of cancer, or of lesions which resemble cancer in some respects and in others do not, that we have the most promising field for investigation. This is true not merely or chiefly because of the possibilities of improving cancer prognosis, but perhaps even more because of the possibilities of bridging the gap, always in the past quite sharply defined, between normal and malignantly growing epithelium.

Up to a few years ago there was only a very small proportion of cervical cases in which there was doubt as to the microscopic diagnosis between malignancy and non-malignancy. This general statement is still true, but there is nevertheless an increase in the number of cases in which diagnosis differs according to the individual interpretation of the pathologist. Two factors are responsible for the development of this relatively new zone of pathological uncertainty. The first is the increasing number of specimens submitted from biopsies of cervices in either very early cases of cancer or, even more, from cervices which are merely suspicious. This increased interest in the cervix is not entirely explainable by educational awakening of the public, important though this may be. In many clinics, however, the new interest in the search for supposed precursors of cancer, such as leucoplacia, and the development of aids in this search, especially the Schiller iodine staining test and the use of the colposcope, have yielded much material in which new angles of microscopic diagnosis must be considered.

The second reason for the difficulties in a small but increasing number of cases comes from the still very wide open question of the microscopic criteria of very early carcinoma. The chief issue which has arisen is this, viz.: Is the microscopic diagnosis of cancer justified on the basis of anaplastic cell changes alone, without evidence of invasiveness, and is it permissible even when there is as yet no evidence of penetration of epithelial growth through the basal membrane? It is around this question that a lively discussion and a large literature has developed within recent years. Up to a few years ago many of us felt that definite evidence of marked anaplastic cell changes, such as polymorphism, hyperchroma-

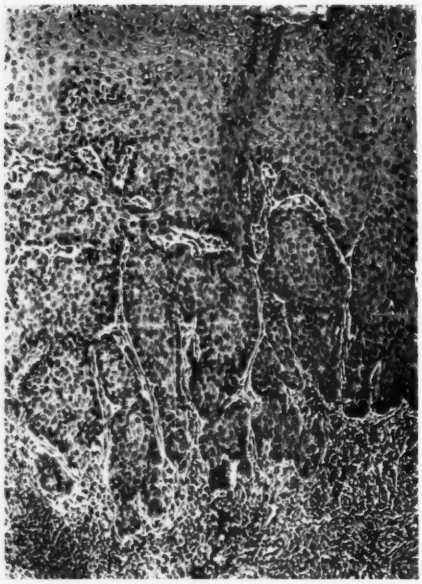

Fig. 1. Early epidermoid cancer of the cervix, measuring only a few millimeters in size, but showing already the same anaplastic and invasive features characterizing the most advanced lesions.

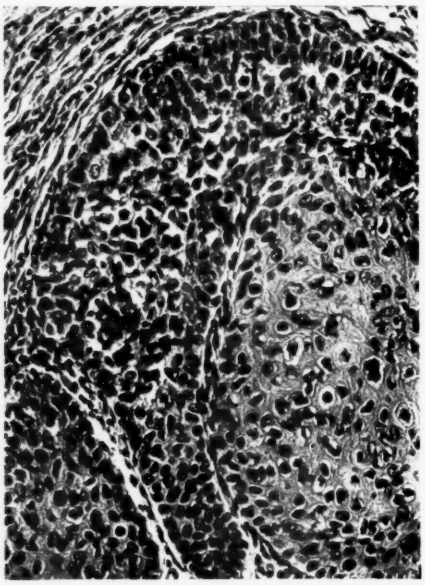

Fig. 2. Anaplastic cell nest located far beneath the surface in the small cancer of the cervix that is shown in Figure 1, illustrating rapidity of invasiveness of even the early lesions.

tosis and mitosis, could scarcely be explained except on the basis of malignant overactivity, and this is still the view of many, perhaps the majority of experienced pathologists. The disturbing factor which has been projected into the picture is the occasional finding of just such anaplastic changes in the epithelium of cases in which there is no clinical evidence of malignancy, and in which the simplest surgical procedure, such as mere excision of the suspected area, has not been followed by the materialization of cancer. Are such cases of intra-epithelial carcinoma, or carcinoma *in situ*, or Bowen's disease, or carcinoid, as they have been variously called, really instances of very early, latent, but ultimate and inevitable cancer, or, is the epithelial change, so to speak, still in a not irrevocable stage so far as the development of cancer is concerned?

The material available for the study of this particular problem in cervical pathology is still much too meager to draw final conclusions, and the impressions of most pathologists on this question must necessarily be colored by their convictions as to the general nature of the cancer process and by analogy with similar lesions elsewhere. Lesions of the type described are rather rare, and their accumulation from the current material of even large clinics is a slow process, justifying no conclusions until the follow-up results are available. Even these are not of the simple nature of laboratory experiments, because the patients' welfare must be the prime consideration, and a doubtful lesion can not be allowed to remain and unfold its nature, perhaps to the great detriment of the patient. We are thus usually denied the opportunity of observing what would have happened to the patient as a result of a given lesion had it been allowed to remain, and had not excision, or cauterization, or cervical amputation, or even hysterectomy or radiotherapy been resorted to. A quicker way to accumulate material for the immediate present would seem to be to go back over all the cervical material in our laboratories, to search for lesions of this

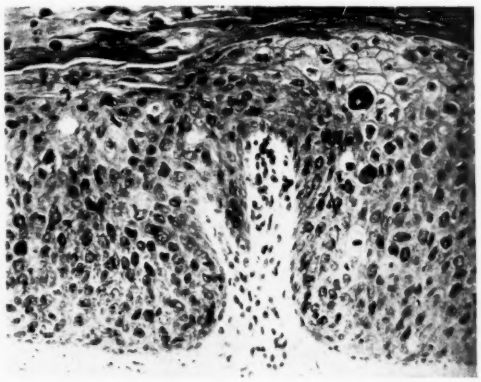

Fig. 3. Microscopic section showing Bowen's disease of the skin. (This illustration is reproduced from Bowen's original paper).

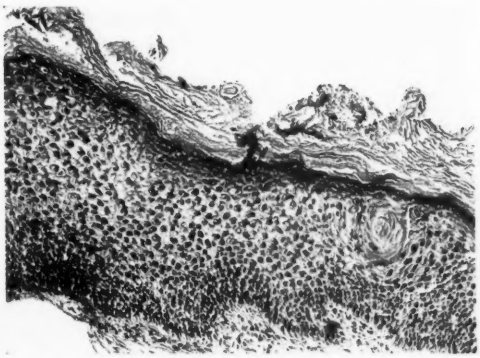

Fig. 4. Microscopic appearance of leucoplacic area, showing cell activity not unlike that of Bowen's disease of the skin. The hyperkeratosis seen in this case is not an invariable finding.

borderline type, often overlooked in the past, and to determine what has happened to the patients. It is probable that within the next 5 or 10 years our discussion of this group of lesions will be much more factual and less theoretical than it is at present.

In the overwhelming majority of the cases of clinically early carcinoma of the cervix, cases which are looked upon as very favorable by present-day standards, the pathologic diagnosis is simple enough, for all the microscopic criteria of malignancy, including invasiveness, are just as clearly stamped as they are in the latest phases. But there are surely stages preliminary to this, stages in which, as most of us believe, the cancer summons has been served upon the epithelial cells, whether from within or from without, stages in which the later penetration of epithelial cells through the basement membrane has not yet had time to manifest itself. (Figs. 1 and 2.)

In even the very early cancer of unquestioned type, with invasiveness already established, we are dealing with an exact miniature of late cancer, with precisely the same histological and growth characteristics. But the invading epithelium has its origin from the surface epithelium, and almost a priori there must be an earlier phase during which the epithelium has not yet gotten out of bounds. These theoretical considerations lend much justification to the growing belief that this pre-invading stage corresponds to the picture of so called intra-epithelial cancer, in which all of the cell characters of cancer are observed, though invasiveness can not be demonstrated. While such lesions are relatively rare, they are being reported with increasing frequency and under various names. In our own laboratory we have been, for the time being, designating them, as have various others, as Bowen's disease of the cervix, because of their essential similarity to the so called Bowen's disease of the skin. (Figs. 3 and 4.)

This interesting dermatologic condition, described by Bowen in 1912 under the name of intracutaneous cancer, is histologically an intra-epithelial carcinoma which may show no invasiveness perhaps for many years, when it assumes all the characters of genuine cancer, including invasiveness and metastasis. Is it not possible for similar lesions in the cervix to remain similarly latent for long periods of time, thus explaining their ready cure in this stage by very simple and conservative measures? The only doubt would seem to be as to the inevitability with which they assume the other commonly accepted characters of malignancy, viz., invasiveness. (Figs. 5, 6, 7.)

It should be remembered that, after all, malignancy is primarily a clinical and not a histological characteristic. By the correlative studies of many years, pathologists have learned that certain histological properties are associated with clinical malignancy. But this knowledge has come chiefly from the study of

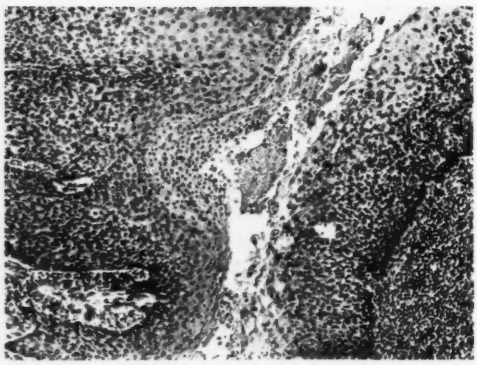

Fig. 5. To left is an early epidermoid cancer of the cervix; on opposite lip is an area of non-invasive intra-epithelial carcinoma, with characteristics not unlike those of Bowen's disease.

outspoken cases. May it not be, however, that the anaplastic cell changes so characteristically associated with malignancy may likewise be seen in lesions which still are to all intents and purposes clinically benign? This does not mean that such lesions have no relation to cancer, for the exact opposite would seem to be the case. The very incomplete evidence as yet available suggests that the so called Bowen's disease of the cervix is really a precursory, pre-invasive phase of cancer, but that it may remain latent in this clinically non-malignant phase for long periods of time. Schiller's designation of intra-epithelial carcinoma as actually "beginning cancer" does not seem to me justified in the present state of our knowledge. A better term would seem to be precancerous anaplasia.

There are very obvious limitations in drawing conclusions as to the nature of cancer from histological and clinical studies alone, but on this basis one gets the impression that the transition of normal epithelium to carcinoma is in two steps. The first of these is concerned with the cell changes, especially de-differentiation and increased growth propensities; the second with the inhibition of some growth restraint which normally limits epithelial growth to its own side of the basement membrane. Apparently, too, there may be a definite and perhaps long lag or pause between the two steps.

A very important point in the evaluation of Bowen's disease of the cervix is the fact that it quite perfectly resembles the picture so often seen at the growing margin of very frank cervical cancer, as Schiller has so well emphasized. It would almost seem, though this must for the present be considered a figure of speech rather than a demonstrable fact, that around the cancer there is an area in which the epithelium, especially in its basal layers, is being lighted up into cancer activity. The cells of the epithelial layer are compactly placed, while hyperchromatosis, polymorphism, and mitotic activity are marked, and here again we have in these peripheral zones the picture of intra-epithelial carcinoma without invasiveness. The junction of this zone with the normal epithelium is sharply defined and often oblique, because of the deeper extension into normal tissue of the basal layers than of the superficial, as Schiller and others have emphasized. The mere fact, therefore, that this growing margin of actual cancer so closely resembles Bowen's disease is circumstantial evidence of a relation between the two, and of the precancerous nature of Bowen's disease.

There are other cervical conditions in which varying degrees of cell overactivity may be noted. One which is now very much in the limelight is leucoplacia, of which almost nothing was heard until a few years ago. In certain other parts of the body, especially the tongue and the vulva, the precancerous nature of leucoplacia has been accepted for many years, but it was not until the work of Hinselmann, based on colposcopic studies of the cervix, that the relatively frequent occurrence of cervical leucoplacia became recognized. Unfortunately, the term is a rather loosely applied one, embracing varying degrees of hyperkeratosis, parakeratosis, papillary enlargement, and evidence of overactivity of the cells. Indeed, Hinselmann's own interpretation of the term includes the cases I have described above as Bowen's disease, as well as cases of early carcinoma. He distinguishes four grades or rubrics of the lesion, varying from simple cornification of the epithelium at one extreme, to cornification, plus marked atypia of cells, plus budding into the connective tissue at the other extreme.

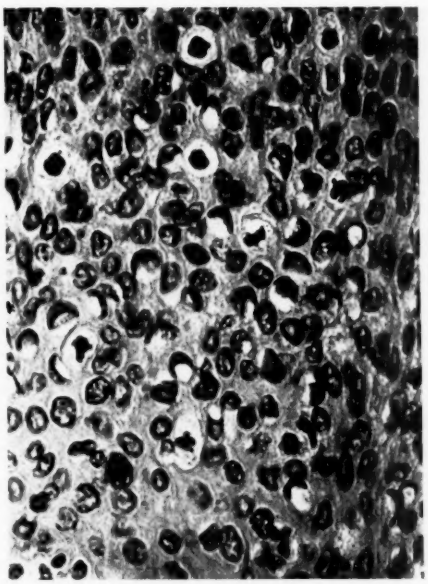

Fig. 6. High power of cancer shown in left of Figure 5, illustrating characteristic anaplastic cell features of malignancy.

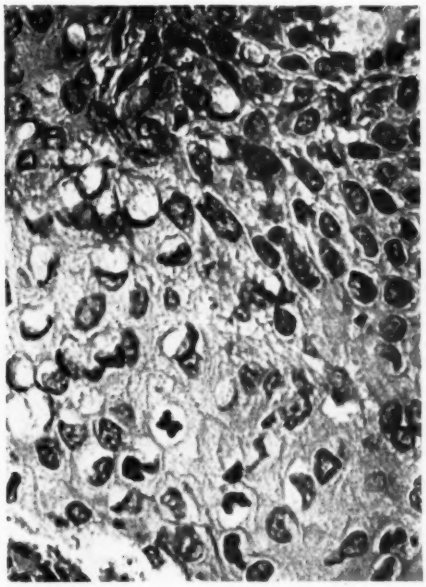

Fig. 7. High power of non-invasive area on opposite lip of cervix (to right in Fig. 5), showing cell changes similar to those in Figure 6.

In the milder grades of leucoplacia there is no microscopic resemblance to cancer, although Hinselmann believes that leucoplacia in general must be considered a precursor of cancer, a view with which many good pathologists disagree. Certainly the chasm between the milder grades of leucoplacia and cancer is a very wide one indeed, while that between his rubric IV and cancer is indistinguishable. Whatever one's opinion may be on the pathological aspects, and whatever one may think of the value of the colposcope, it seems to me that Hinselmann has rendered a very great service in emphasizing the value of very intensive and painstaking study of the cervix in the search for early cancer. (Figs. 8 and 9.)

The magnification of the cervix afforded by his colposcope or any of the modifications which have been devised (a very good apparatus which I myself use is manufactured by an American firm) is really quite educational, giving one a new clinical slant on cervical pathology. The method, however, is time-consuming and its value significant only with increasing experience. I do not believe that the additional information which it gives, above that of simple and thorough inspection of the cervix in a very good light, is as great as Hinselmann believes it to be, nor do I think it will reveal any large number of early cancers that a good gynecologist would not discover with the simpler methods of inspection. Moreover, it is not the sort of diagnostic aid which is adapted for general use among general practitioners, for it is valueless without a knowledge of the significance of the cervical pictures which are revealed, and without a proper pathologic interpretation of these lesions after biopsy.

In competently manned clinics, however, the apparatus is a real asset, for it will serve to keep constantly before the staff members the fact that the recognition of early cancer is not a mere matter of palpation and casual inspection, but that it requires very concentrated and painstaking study by one method or another. It is of no practical value in the study of outspoken cancer, and indeed it is meant chiefly for the "accidental" finds, since

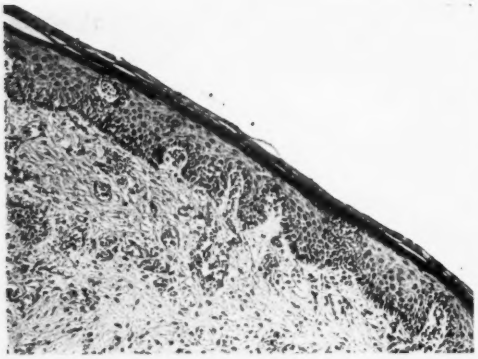

Fig. 8. Section from small area of "leucoplacia," not taking the iodine stain with Schiller's test, and showing merely hyperkeratosis and slight increase in cell activity, but with no suggestion of malignancy.

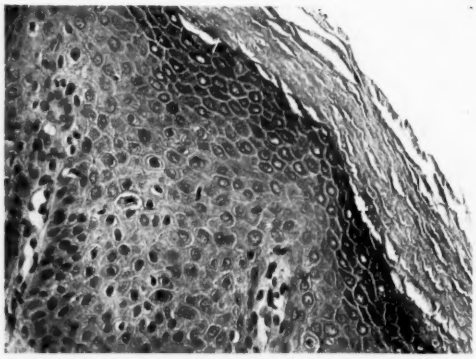

Fig. 9. Another "leucoplacic" area. Here again are shown hyperkeratosis and some increase in cell activity and a few mitoses, but there is no suspicion of malignancy.

the lesions which it aims to reveal are so commonly symptomless. It should logically therefore, though this is rarely feasible, be employed in almost a routine fashion.

It is of interest to note, from a recent report by Lönne, that during the 10 year period during which Hinselmann has employed the method, he has examined a total of 18,000 patients with the colposcope, and that among these he discovered 450 instances of leucoplacia, of which 2 per cent proved to be malignant. In 87 of his cases diagnosed as malignant, the diagnosis was confirmed in only about one-half the cases by a group of three expert pathologists (Meyer, Schridde, and Rœssle). It is illuminating, too, from the standpoint of the thoroughness of the study required with such material, to learn that as many as 1,200 to 1,500 sections were made of some 500 cervices which had been amputated.

The Schiller test. What has been said as to the limitations of colposcopy applies very largely to the employment of the Schiller tinctorial test, whether combined with colposcopy or not. The method is based on the fact, pointed out by Lahm, that the normal vaginal mucosa, as well as the stratified squamous epithelium of the pars vaginalis, is rich in glycogen. Cancer epithelium, however, is glycolytic, and this fact has been utilized by Schiller in the iodine test which he devised. This consists in painting the cervix thoroughly with Gram's solution, consisting of 1 part of iodine and 2 parts of potassium iodide to 300 parts of water. This solution gives better results than Lugol's solution, which has often been used for the test. Schiller advises that the solution be poured into the vagina and liberally mopped over the cervix, with care to avoid traumatism of the mucous membrane, as this may lessen its tinctorial response. Henriksen suggests as a modification that the solution be sprayed freely over the cervix with an atomizer. Excessive mucous secretion should first be gently removed, and after a half minute or so, to allow the stain to take hold, excess solution should be sponged out.

Normally the squamous epithelium of the cervix takes a homogeneous deep mahogany-brown stain, while cancer areas remain unstained, so that they stand out in sharp contrast. Unfortunately, the matter is not quite so simple and decisive as this, for other lesions which are not malignant, especially leucoplacia, also remain unstained, while traumatism of the mucosa may also interfere with the staining reaction. The cylindric epithelium of the cervical canal normally takes a rather light brownish-pink stain, and this must be taken cognizance of in the cervices in which eversion or erosion is present, as it so often is. In ulcerated carcinoma, a dirty brownish stain may be assumed in the ulcerated area, though a whitish zone may be noted surrounding this, corresponding to the advancing margin of growth.

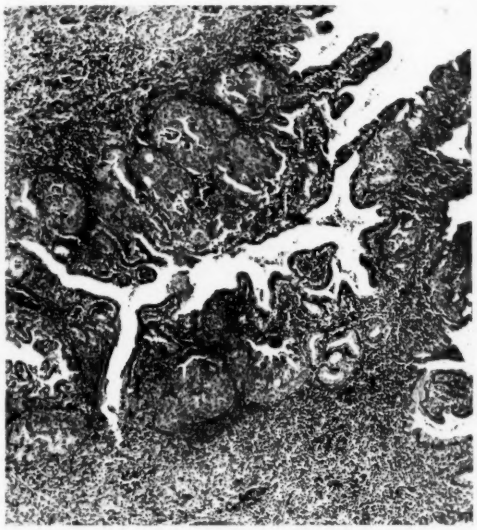

Fig. 10. Marked epidermidization or "squamous metaplasia" of cervix, producing an appearance which might lead to suspicion of malignancy if one is not familiar with this picture.

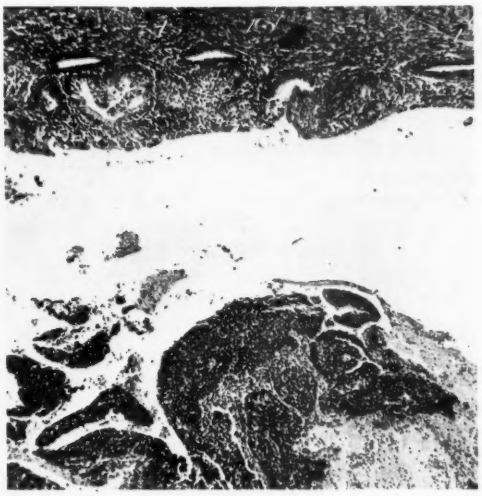

Fig. 11. Showing the contrast between benign epidermidization on one lip of the cervix (above) and real cancer on the other lip (below).

The whitish areas of leucoplacia, like those of early cancer, are characteristically to be looked for at the junction of the squamous and cylindrical epithelia. The leucoplacia areas may be single or multiple, very tiny or at times quite extensive. Since the distinction between a leucoplacic area and a very early cancer can not be made on the basis of the Schiller test alone, the chief value of the test would seem to be to point out areas for biopsy. It is probable, therefore, that few general practitioners will wish to assume the responsibilities of the Schiller test themselves, carrying with it the further responsibilities of pathological interpretation, and that they will usually prefer to transfer the problem to the specialist. Furthermore, as was emphasized with reference to the colposcope, the Schiller test is of little additional value in the detection of outspoken cancer, its possibilities being greatest in the routine examination of cervices of patients who have no symptoms of cancer. Once bleeding occurs, it may be assumed that ulcerative changes have already begun, and diagnosis is usually easy, at times pathetically so, even without such refinements as this test.

Squamous metaplasia simulating cancer. There is one other group of cervical lesions which can not be overlooked in any discussion of the microscopic diagnosis of early cancer, particularly because of their very great frequency, far greater than of those already discussed. I refer to the so called squamous metaplasia, or epidermidization, seen so often in chronic inflammation of the cervix, as well as in polypi. I have discussed the characteristics and the mechanism of this interesting change rather fully in a previous paper, so that I shall not elaborate upon it here. Suffice it to say that the condition is characterized by the presence beneath the cylindric epithelium of the cervix, either on the surface or in the glands, of columns or islands of squamous epithelium which often proliferate extensively, so that they frequently obliterate the cylindric gland epithelium and fill the gland. In advanced cases one sees columns and nests of this epithelium scattered throughout the stroma, so that there is more or less resemblance to the epidermoid cancer. The distinction can usually be made by the normal, non-anaplastic character of the cells, and by the fact that the squamous growth follows the scaffolding of the glands. Practically always,

in one field if not in another, remnants of the gland epithelium can be seen within the squamous nests, at times only in the form of multiple small spaces with mucoid content, giving such areas a fenestrated appearance which may even resemble adenocarcinoma. (Figs. 10 and 11.)

There is not the slightest doubt that, in the days of surgical treatment for cervical cancer, many an operation was needlessly performed because this squamous metaplasia was mistaken for cancer, while even now the misinterpretation of such lesions in biopsy specimens subjects some patients to unnecessary radium treatment. For the lesion is a frankly benign one, with no evidence of that ominous speeding up of cell activity which characterizes some of the others which have been discussed. It has, so far as we know, no more relation to actual cancer than has any other form of chronic inflammation, and such lesions can therefore be eradicated by very simple and conservative measures, such as cauterization.

Whether the squamous epithelium originates from a genuine metaplasia, or whether it is derived from certain indifferent cells beneath the cylindric epithelium, or whether it arises from the proliferative tendencies of the basal layers of squamous epithelium, leading it, in such lesions as healing erosions, to flow down along and beneath the columnar epithelium, need not be here discussed. But the characteristics and the significance of the lesion, as well as its relative immediate innocuousness, should be familiar to every pathologist.

Biopsy. When all is said and done, biopsy remains the most important diagnostic procedure in cases in which the gross lesion is of doubtful but suspicious nature. Regardless of how it is carried out, whether by scalpel, punch, or endothermy knife, the important thing is to excise the tissue at the point which is really suspicious. The trained gynecologist will rarely have any difficulty in detecting this, if the cervix is well exposed under a very good light. Unusual hardness, slight superficial granular ulceration, the presence of a finely vegetative area, increased vascularity as manifested by bleeding on slight touch, all these must be sought for. Not infrequently wedges are taken from more than one area, in order not to miss the possible malignancy. In my own work I prefer the scalpel for biopsy if the cervix is easily accessible, the wound being then seared with the electric cautery. When the use of the scalpel is awkward and difficult, as it is with a cervix high up in a narrow vagina, a punch is better for the purpose. Others prefer the fine cautery or endothermy knife, though with the former the excised tissue may be partly cooked, so that the sections may not be so satisfactory. Schiller's suggestion of biopsy by surface curetting was obviously designed for cases where there is no localization of suspicion, and is far less satisfactory, it seems to me, for the usual case, in which there is a localization of suspicion.

The pathologist can be expected to find cancer only when it is contained in the biopsy specimen, so that a biopsy improperly performed or taken from the wrong area, is not merely useless, but actually inimical to the patient's welfare. In such a case the pathologist will report that there is no evidence of cancer, and the clinician feels quite secure, while the malignant lesion may be progressing only a few, though sometimes many, millimeters from the edges of the biopsy wound. On the other hand, the pathologist may err if he depends for diagnosis on one or two sections from the biopsy block, for in small lesions sections from other levels may show undoubted cancer. Serial sections are therefore of great importance, and it is best to section the entire block, staining sections at various levels so that the evidence of malignancy will not be missed if present in the block.

Another practical suggestion concerns the frequent advisability of performing amputation of suspicious cervices rather than simple biopsy. This applies particularly to patients beyond the menopause, where there is no obstetrical contra-indication to amputation. If no cancer is found, the procedure has genuine prophylactic value. With the whole cervix available for microscopic study, there should be little chance for missing cancer if it is present, so that appropriate radiotherapy may then be instituted.

I have said nothing as to the supposed danger of biopsy because of the possibility of disseminating cancer cells. There has never been any worthwhile evidence that this is a hazard of importance in this field, and, as a matter of fact, there is considerable evidence to throw doubt upon its harmfulness in any field of the body. The practical point, however, is that even if there were some danger attached to biopsy, it would still be both justified and necessary, for how else can we settle the vital question of diagnosis in doubtful cases?

TREATMENT

Having devoted so much time and space to the matter of diagnosis, the question of treatment may be considered only rather briefly and along general rather than detailed lines, especially as these details have been so fully discussed by others during the program of this Institute. It is now generally accepted that the backbone of our present day treatment of cervical cancer is radiotherapy, for reasons which I have indicated in the early part of this paper. The old discussion of surgery versus radium has been replaced by the question of whether there is now any place at all for radical surgery in the treatment of this disease.

In many clinics operation has been virtually abandoned, but there is noticeable a growing tendency to modify this policy by adopting a combination of surgery and radium in at least a selected group of cases. In those patients in whom the disease is in a relatively early stage, when the patient's general condition is favorable for a major surgical procedure, when the surgeon is well trained in the technique of the radical operation, and especially when the cancer is of the highly differentiated type which is characterized by a low degree of radiosensitivity, the radical operation is a rational procedure. The mortality rate in this group should be low, and is probably at least counterbalanced by the fact that the cancer tissue is actually removed rather than subjected to the destructive effects of radium. This advantage applies especially to the cases in which the cancer cells are of the highly differentiated type known to be relatively radioresistant. In cases of this group, the hope is that the cancer has not yet found its way into the parametrium or glands. If it has, the prospects of cure by either surgery or radium are poor.

It need scarcely be added that the aggregate number of cases coming under the above specifications is only a small fraction of the total number encountered. When operation is to be carried out, it should, according to Burnam, be done within a few days after the application of radium if this be used before operation. There are, however, differing viewpoints on this point, some advocating much longer delay, perhaps as much as 6 weeks (Anspach). The shorter period seems wiser, according to Burnam, because the fibrotic changes following radiotherapy, and often making operation much more difficult, will not have had time to develop. Postoperative radiation is, in most clinics, looked upon as a more valuable adjunct than pre-operative radiation. There are, too, cases in which the cancer is of the less early and radioresistant type, in which after preliminary radiation to abolish infection and dry up the cervix, removal of the cancerous uterus is probably advisable.

The present popularity in Germany of vaginal hysterectomy, often combined with radiotherapy, has not spread to this country, though in some cases it no doubt presents definite advantages, especially in the lower mortality accompanying its use in the hands of those highly trained in the technique of the vaginal procedure.

With the exception of these limited groups which I have discussed, the treatment of cancer of the cervix is entirely a matter of proper radiotherapy, with the combined use of radium and the x-ray. In Baltimore this treatment is referred entirely to a group of trained radiologists, and Dr. Burnam, who has directed this work for many years, has reported his technique and his results in various papers, so that there is no need for discussing details here, even were I qualified to do so. There is still considerable difference in methods, and improvements and refinements are still being devised in an effort to improve results. The dangers of radiotherapy are real, and the morbidity attending the method has been

emphasized by many authors. In the main, however, the risks of radiotherapy in competent hands are only a small fraction of those of the radical surgery formerly so generally employed, and this fact, together with the fact that the results are just as good, to say the least, has established radiotherapy as the preferred treatment of the present.

If only surgery or only radiotherapy were to be chosen for universal adoption, there can be no question as to which would give better results and carry with it the lower mortality and morbidity. But the keynote of treatment of cervical cancer should be individualization, so that the plan of radiotherapy must be adapted to the individual case, while in some a combination of surgery and radiotherapy will be chosen as offering the patient the best chance for cure.

SUMMARY

Aside from individual and collective efforts in educating women as to the early signs of cancer and as to what little we know of cancer prophylaxis, the chief contribution which the general practitioner can make to the cancer campaign is the intensive study of the cervices which he has occasion to examine. In such studies he must not look merely for the obvious cancer picture, but he should search carefully for the early lesions and those which are merely suspicious, and in these he should unremittingly press for accurate diagnostic differentiation, which will generally mean biopsy and microscopic examination.

The task of the gynecologist and pathologist in differentiating the benign from the malignant is usually comparatively easy, but in a certain group of cases may be difficult. This group is becoming larger in many clinics because of the present day interest in such lesions as leucoplacia, believed by some to be an important precursor of cancer. In such intensive studies on the cervix the colposcope and the Schiller test, both of which are discussed at length in this paper, are of great value, though both have many limitations, and neither would seem to be suited for general use among practitioners.

The term leucoplacia is rather loosely applied, in a clinical rather than a pathological sense, to lesions showing varying degrees of hyperkeratosis and abnormal cell activity. In spite of the fact that leucoplacia in general is thought by some to be a precursor of cancer, its milder forms exhibit no microscopic suggestion of malignancy. In other types, such as the lesion known variously as carcinoma *in situ*, carcinoid, intra-epithelial carcinoma, or Bowen's disease of the cervix, there is much reason to believe that we are dealing with a pre-invasive phase of actual cancer, though a long latent period may ensue before the development of actual invasiveness. Not until the latter begins, however, can we properly speak of actual beginning cancer.

The treatment of cervical cancer is briefly discussed. The prevailing popularity of radiotherapy is fully justified by the fact that it gives final results just as good as those of even expert surgery, with a much lower primary mortality and morbidity rate. In a small group of cases, however, surgery, often combined with postoperative radiotherapy, is still a rational procedure, and in this group are especially to be placed early cases of a radioresistant type, in which the patient is a good operative risk and the surgeon is well trained in the technique of the radical operation.

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THE DIAGNOSIS AND TREATMENT OF TUMORS OF THE BLADDER BY MEANS OF ROENTGEN-RAYS

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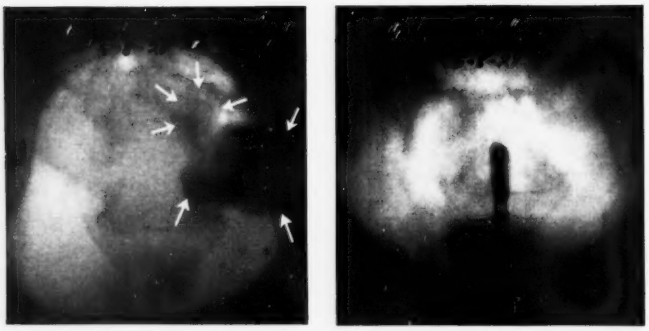
TUMOR of the bladder should be thought of whenever the patient passes bloody urine, or when there is unexplained frequency, pain, or difficulty in urination, even though in most instances these symptoms may be found to be due to other conditions. Early diagnosis and thorough treatment from the beginning is just as important in cancer of the bladder as in cancer elsewhere. The earliest diagnosis can be made by cystoscopy, and in bringing to your attention the use of the roentgen-rays in the diagnosis and treatment of tumors of the bladder, there is no thought of replacing cystoscopy. The two methods supplement each other. Each method is useful by itself, and generally, a diagnosis can be made by either method alone but one obtains information by means of pneumocystograms that cannot be obtained by cystoscopy. I have been using pneumocystography since 1908, and so far as I know, I have been the first. This method has been discussed by me in various roentgenological meetings, since that time. A formal presentation was made together with a lantern slide demonstration of a number of tumors of the bladder before the Philadelphia Roentgen Society, on May 5, 1919.

Tumors of the bladder can be demonstrated by the roentgen-rays after filling the bladder with air, which furnishes the contrast media. Some information can also be obtained by means of opaque material injected into the bladder. According to my observations, however, opaque material has been very much less satisfactory. Tumors as small as half a centimeter in diameter, and as large as a fist have been shown by this method. In addition to the actual diagnostic value, pneumocystograms furnish a photographic record of such tumors, and such records permit the study of the tumors in series to show the progressive reduction under roentgen-ray treatment, for such records are more accurate than word pictures.

The study of bladder tumors by means of pneumocystograms has another very great advantage over cystoscopy in that pneumocystograms show the degree of infiltration of the bladder wall. The demonstration of the induration is possible because the part of the bladder which is normal will distend smoothly and evenly. The part of the bladder which is infiltrated does not distend, an indentation appears or the part hugs more closely to the median line. On the other hand, a papillary growth that has not infiltrated the bladder wall permits distention of the bladder wall, and at the same time permits a projection of the tumor into the bladder area. In such cases, the bladder outline may be spherical. It is well known that if a tumor of the bladder has not infiltrated the bladder wall and the surrounding tissues, there is more opportunity of curing it. The papillary type of cancer is more responsive to irradiation than the infiltrating variety and more rapid results are obtained. Furthermore, the study of the tumor by pneumocystograms gives the radiologist a more definite idea as to the location and enables him to direct the rays more accurately into the base of the tumor by crossfiring on this point, whereas if the roentgenologist must depend merely upon the word description by the cystoscopist, he cannot locate the tumor so well, nor take the greatest advantage of the crossfiring method of treatment. Sometimes there is so much bleeding that the cystoscopist experiences difficulty in getting a clear view of the tumor tissue. In the diagnosis and treatment of tumors of the bladder, it is advisable to have co-operation between the urologist and radiologist. I have been fortunate in having such association.

Professor of Radiology, University of Pennsylvania, Graduate School of Medicine. Presented before the Twenty-First International Medical Assembly Interstate Post-Graduate Medical Association of North America, October 12–16, 1936, St. Paul, Minnesota.



A B

Fig. 1. Case 1. A. T. J. T., a man, aged 49 years, referred March 21, 1925, by Dr. F. J. Dever on account of carcinoma of the glans penis, which had existed for 1 year. He was treated successfully by radium, x-rays, and electrocoagulation. A, 3 years later, June 8, 1928, the patient returned with a history of hematuria for 6 months. The pneumocystogram shows an ulcerating, broad-based tumor of irregular density, occupying the left wall of the bladder and extending over toward the region of the left ureter. It projected into the bladder 5 centimeters, and the base was 3 centimeters. A second tumor on the posterior wall of the bladder was approximately 2 centimeters in diameter. B, After treatment by high voltage roentgen therapy and also by cystoscopic electrocoagulation, done by Dr. Wilbur Haines. A pneumocystogram made May 8, 1929, shows tumors entirely gone. The bladder is normal throughout. The patient is well, more than 7 years after treatment.

METHOD OF EXAMINATION

Briefly, the examination of the bladder by pneumocystography requires the following:

1. The patient is placed in the supine position upon the Potter-Bucky diaphragm with preliminary arrangement of the tube and compression band as for an examination of the bladder.

2. The urethra is carefully cleansed antiseptically.

3. A sterile, well lubricated soft rubber catheter of the largest size that the urethra will take is introduced.

4. The retained urine is drained. The quantity and character of this urine is noted.

5. A rectal tube is passed to remove any retained gas in the rectum, and then removed.

6. With an atomizer bulb, attached to a properly fitting glass tube which connects the catheter, air is gently injected into the bladder until the patient complains of a desire to urinate or until percussion indicates that the bladder is distended.

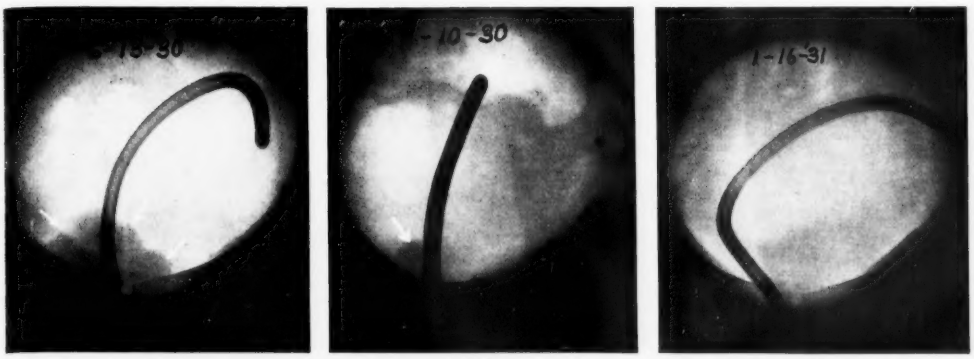
7. The air is allowed to escape 2 or 3 times. This will commonly remove some additional residual urine. It is desirable to eliminate all possible residual urine, which may diffuse or obliterate the shadow of the tumor.

8. The soft rubber catheter is clamped with a pair of hemostatic forceps and these forceps are attached with adhesive plaster to the thigh so that the catheter will not come out and the air will not be expelled.

9. The central beam of roentgen-rays is directed downward and forward and, with the patient in the supine posture, three or four 8 by 10 inch negatives are made.

10. The catheter is held in place while the patient turns to the prone position on the Potter-Bucky diaphragm most cautiously so as not to have the catheter and the air expelled.

11. Three or four 8 by 10 inch negatives are made with some variation of exposure value with the central beam of rays directed obliquely upward, so as to project the neck of the bladder clear of the pubic bone. A film made with patient in the prone position usually shows the tumor best because such films usually involve the posterior or lateral wall of the bladder, and in this position are therefore surrounded by air. According to O'Crowley,



A B C

Fig. 2. Case 2. Mrs. G. W. S., aged 55 years, was referred by Dr. J. M. Anders, June 13, 1930, on account of hematuria, for several months. A, Tumor irregular in outline, with a broad infiltrating base surrounding the urethra, about the size of a hen's egg. The patient was given high voltage roentgen treatment. B, After 3 months, on September 10, 1930, re-examination showed that five-sixths of the tumor had disappeared. All the patient's symptoms had gone. C, After 6 months, on January 16, 1931, the patient was re-examined and all the tumor had disappeared. On July 28, 1932, examination showed that the bladder was entirely well. The patient is without symptoms at the present time, more than 6 years after the treatment has been completed.

27.37 per cent involve the trigone; 41.89 per cent involve the lateral walls; 5.89 per cent involve the bladder neck; 10.92 per cent involve the posterior wall; 7.85 per cent involve the vault; and 6.32 per cent involve the anterior wall.

12. The patient is rotated in the oblique prone position, first on one side and then the other, and the central ray is passed through the median line of the bladder, one 8 by 10 inch film being made in each position.

13. The patient is rotated cautiously to the back, the clamp is removed, the air is allowed to be expelled, and the catheter is withdrawn.

14. The patient can then leave the table and either undergo treatment or go home.

In only one case in several hundred has there been any chill or any other unpleasant symptom following these examinations. There is no real danger of embolism following this procedure if the work is carefully done.

INTERPRETATION

We have succeeded in demonstrating both benign and malignant tumors, varying in size from 1 to 8 centimeters. It is not always possible, of course, to make an exact pathological diagnosis by means of pneumocystography as to whether the tumor is malignant or benign, just as it is not always possible to make a diagnosis cystoscopically or macroscopically. In general, however, if a tumor is small, sharply defined and pedunculated, and especially, if there are multiple tumors, the probabilities are that it is benign. If it is large, irregular on the surface, and associated with a broad base, it is probably malignant, and if it is infiltrating in character, it is I think always malignant. If the tumor has definitely infiltrated the bladder wall so that it can not stretch normally, one obtains more definite evidence of a malignant growth than could be obtained cystoscopically.

Since urologists state definitely that all tumors of the bladder are potentially malignant, the important matter is to demonstrate the tumor and to get rid of it by the best means possible, according to the indications in any individual case.

TREATMENT OF TUMORS OF THE BLADDER

Through the kind co-operation of the surgeons and urologists with whom I have been associated, I have been privileged to make various combinations in the treatment of bladder tumors, such as (1) excision, preceded or followed by irradiation; (2) cystotomy and direct surface application of radium; (3) cystotomy, electrocoagulation, and insertion of radium needles or seeds; (4) cystotomy, elec-

A B C

Fig. 3. Case 3. Mrs. F. McG., aged 43 years, referred by Dr. Albert Bothe, on October 26, 1933, had hematuria 6 weeks following a fall, with no pain. A, Cystoscopic examination and pneumocystograms show a sharply defined tumor, approximately 2 centimeters in diameter, located about 5 centimeters to the left of the urethral orifice. This tumor has associated with it the shadow of a second smaller tumor, which has double the density, but which is still sharply defined. A second papilloma is located at the left border of the sphincter, and approximately 0.5 centimeter in diameter. A third papilloma is located about 8 centimeters to the left of the sphincter. All these lesions have the appearance of being benign, as determined both by cystoscope and by pneumocystogram. No biopsy was done. B, December 4, 1933, these lesions were reduced in density, and reduced in size, approximately 50 per cent. The third lesion at the left wall of the bladder is entirely gone. Following this pneumocystogram, Dr. Bothe destroyed the remainder of the tumors, cystoscopically. C, May 7, 1934, the tumors were entirely gone, and the bladder wall was smooth and healthy. The depression in the upper right border is due to the distended cecum. The patient has remained in excellent health during a period of 3 years.

trocoagulation, and surface application of radium to the base of the tumor; (5) preliminary roentgen therapy, local destruction, subsequently followed by additional roentgen therapy; and (6) high voltage roentgen therapy, with high filtration, supplemented, if necessary, with electrocoagulation (through the cystoscope) of any remnant that does not respond to irradiation. Our most brilliant results, which have been the most pleasing to the patients, have been obtained by the last method.

In the discussion of this subject before the Pan-American Congress in 1934, Dr. James K. Young stated that 75 per cent of cancers of the bladder are inoperable when they come to see him. O'Crowley says, "In view of the fact that those tumors on the lateral wall usually involve the ureteral orifices, it can be seen that these tumors located in this region with those on the trigone and bladder neck constitute 76.6 per cent. This therefore brings out clearly the fact that in only 23.4 per cent of tumors is it possible to apply complete excision without interfering with the ureter or urethra." It is my opinion that any method of treatment that will get a patient well should be used, and that method should be chosen which will give the least risk to the patient, the least damage to his tissues, the least interference with his work or body functions. In the 23.4 per cent of tumors, therefore, there is naturally debatable grounds as to the best method, but in the other 76.6 per cent, the roentgen treatment will certainly meet these demands more completely than anything else that is known.

Simple benign tumors are being destroyed daily by urologists by cystoscopic electrocoagulation, but it is also well known that these tumors commonly recur after such treatment. Therefore, it has seemed to Dr. Bothe and me that it would be advisable to give preliminary irradiation, then destroy the tumor and follow with an additional moderate amount of irradiation. We have had some success by this procedure.

In dealing with large and definitely malignant tumors, no rule or definite plan of treatment can be laid down at the present time. Each patient must be treated according to the individual conditions present; the general principles of treatment and the general condition of the patient must be kept in mind. Therefore, it is not merely a problem of physics. Such a plan of treatment can probably be best and most practically made if there is a conference with the family physician, the urologist and the radiologist, for all three of these physicians need to co-operate in order to obtain the best results in the greatest number of cases. The principles involved are:

1. To deliver enough irradiation into the tumor tissue to destroy the cancer cells. This will require from 3,000 to 6,000 r (roentgens) delivered into the tumor area.

2. To accomplish this without serious or permanent damage to the patient's normal tissues. We therefore plan to give treatment to the patient through as many portals of entry as is possible which will permit accurate crossfiring on the disease, and by delivering 200 to 250 r (roentgens) daily, or 150 twice daily, we will do less damage to the overlying tissues, and will accomplish probably the best results. We utilize for this purpose 200 kilovolts; constant potential, 2 millimeters copper filtration or its equivalent, usually at a distance of 50 centimeters, making use either of 2 or 4 milliamperes of current, so as to prolong the irradiation effect as much as possible. Considerable skill is necessary in directing this beam of rays toward the disease and we believe, in general, only a physician has sufficient knowledge of the anatomy and the location of the essential organs to do this properly.

3. The treatment must be given in a manner consistent with the patient's general condition. Generally, we are not involved with much radiation sickness in these cases, but the patient may be anemic from loss of blood, from the effects of the carcinoma, and even the radiation becomes exhausting to the patient. We therefore ask for a careful blood study in the beginning, and this is repeated from time to time. Tonics and medication are given sufficient to keep the patient in as healthy and comfortable condition as is possible.

4. It should be our aim to direct the irradiation to the tumor and any adjacent likely extension. I have failed on 2 cases, as I will demonstrate to you, because I did not reach the outlying disease. The pneumocystograms are especially useful in outlining the extent of the growth and in locating its exact position. The radiologist should then direct his beam of rays into this area conserving the normal tissues in every way possible. One must be especially cautious about damage to the subcutaneous tissue of a fat abdominal wall. As has been observed by every surgeon, the fatty tissue in the abdominal wall is not well supplied with blood vessels, therefore, these small vessels are apt to be closed by an endarteritis due to the heavy irradiation, and such fatty tissue is more apt to be followed by fibrosis or necrosis than other tissues. This must be kept in mind in planning the treatment.

5. Repeated checks must be made to determine what has been accomplished, and the treatment is supplemented when necessary so as to eliminate all of the disease. This should be done according to the indications, both by pneumocystography and by means of cystoscopy. I think I failed on one case because I did not have a cystoscopic examination made when I thought the patient was well, as determined by the pneumocystograms, and stopped treatment too soon.

Generally speaking, these patients are able to come back and forth for their treatments, and generally, they are only interfered with in their usual occupation or affairs for the time involved in the actual treatment. If patients have lost much blood by hemorrhage or are very anemic, they must of course conserve their energies in every way possible, and therefore, should be kept at rest. Patients whose general health is good to start with usually do better. I have treated two physicians who had each a large practice, and who continued their practice during their entire treatment.

RESULTS OF TREATMENT

Generally, there is a cessation of hematuria at the end of 3 or 4 weeks. This does not indicate, however, that the disease has disappeared. In one case, the hematuria ceased at the end of 3 weeks, the tumor only showed reduction of about 25 per cent after a period of 4 months, and then there was rapid reduction, and at the end of 6 months, a remnant was destroyed by electrocoagulation. There has been no recurrence at the site of that tumor since. Some benign papillomas developed about the urethral orifice which were controlled by a combination of electrodesiccation and irradiation. In the more sensitive type of tumor, there is very decided reduction in the size at the end of a month, but in others, as indicated, there is almost no change. It must

be borne in mind that the more sensitive types of tumor are also the group that are apt to give rise to metastasis, and one is apt to fail from metastatic involvement even though success has followed the local treatment.

Cystitis is apt to be a complication before, during, and after the roentgen treatment and must be dealt with just as cystitis would be treated under any other conditions. Anemia must be counteracted.

We aim to give the planned treatment within a period of a month, which means from 20 to 25 treatments, but this number of treatments may have to be doubled or tripled. It is our aim to give as little treatment as will accomplish the results. The more accurately the disease is localized and the smaller the extent of the disease, the smaller will be the portals through which the irradiation is given, and the more one can conserve the normal tissues. On the other hand, if one confines the treatment to too small an area, some remnant of the disease will be missed and recurrence will follow. Careful investigation and keen clinical judgment is necessary. Too few patients have been treated to make statistics of any value. For the present, the striking results obtained in individual cases seem to be convincing, as to the value of the treatment.

CONCLUSIONS

1. Since only about one-fourth of the patients with carcinoma of the bladder can be treated surgically without interference with the urethra or ureters, therefore, three-fourths of the cases should be treated by irradiation.

2. Highly filtered high voltage roentgen treatment seems to accomplish more satisfactory results than other methods, especially in the inoperable group.

3. The treatment involves less suffering and less interference with the daily habits than any other form of treatment.

4. Insufficient cases have been treated by this method to make statistics of any value, but my impression would be that we may expect disappearance of the tumor in from 30 to 50 per cent of cases.

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GLUCOSE TOLERANCE AS A DIAGNOSTIC AID IN JAUNDICE

II. Further Differentiation of Cases Showing an Obstructive Type of Curve

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IN A previous communication[1] it was pointed out that in cases of jaundice the blood sugar curve following the ingestion of 100 grams of glucose, conforms to certain type reactions which, if properly interpreted, might help in differentiating between toxic and obstructive jaundice. The obstructive curve is characterized by a rise in the blood sugar which fails to return to normal at the end of the 2 hour period. This curve in its various modifications was obtained in those cases of obstructive jaundice due to calculi, stricture or suppuration of the common duct, and carcinoma of the head of the pancreas or ducts. It was also obtained, however, in those jaundice cases included in the so called intrinsic hepatic group, as cirrhosis, liver abscess, and primary or secondary carcinomatous infiltration of this organ. In continuing these studies it was felt that a great deal of additional benefit could be obtained if one could have some means of separating these so called pure obstructive cases of jaundice from those due to intrinsic liver disease.

The procedure which we have found helpful in making such a distinction was discovered in the course of treatment of cases of cirrhosis associated with jaundice. It was noted in these cases that the icterus would gradually clear when these patients were put on the following therapeutic regimen: (1) daily intramuscular injections of liver extract; (2) 10 units of insulin, twice a day; (3) high carbohydrate feeding. Further studies were then made in order to utilize this therapeutic response in differentiating these various cases.

PROCEDURE

After the patient has been found to show an obstructive type of sugar tolerance curve, the practical diagnostic difficulty really lies between the non-surgical or cirrhosis cases, and the surgical cases due to some obstructive lesion of the common duct. The following procedure was employed in studying these cases.

1. The patient is given daily intramuscular injections of liver extract for a period of 2 to 3 weeks.
2. High carbohydrate diet with an additional daily intake of 250 grams of glucose is allowed.
3. The injection of 10 units of insulin is given morning and night.
4. The icterus index is determined about every 3 or 4 days.
5. At the end of this period of time, the sugar tolerance is repeated.

OBSERVATIONS

It was found that with this procedure, patients with jaundice due to benign fibrosis of the liver showed (1) a gradual decrease in the jaundice as measured by the icterus index; (2) the sugar tolerance curve changes from an obstructive type at the beginning of the period to a non-obstructive type at the end of the period. Such changes as these do not occur in the malignant involvement of the liver or in the case of obstruction of the common duct. These observations may perhaps be made much clearer by the following case reports.

CASE 1. Patient M. C. H. N. 28899. Male, age 56 years, was admitted to the hospital June 16, 1936. He had been confined to his bed for 1 week prior to admission with severe attacks of abdominal cramps and vomiting. His druggist prescribed for him and he was able to go to work 4 days ago, but could only stay there for a few hours and then had to return home. His family noticed that he was distinctly jaundiced. The severe abdominal pain and vomiting persisted and admission to the hospital was advised by the local physician. The patient's past history revealed that he was a very heavy drinker and had been in the habit of consuming about 20 to 30 glasses of beer and a quart of whiskey for the past 25 years.

From the Medical Service of Dr. A. L. Garbat, Lenox Hill Hospital.

[1] Jacobi, Harry G. Glucose tolerance as a diagnostic aid in jaundice. Surg., Gynec. & Obst., 1936, 63: 293–297.

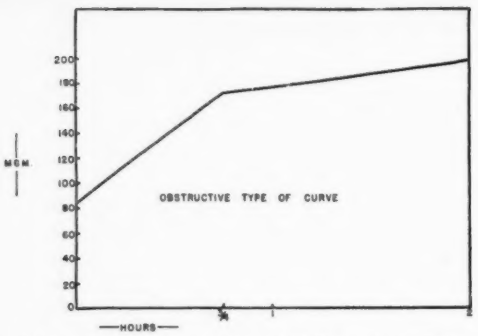

Fig. 1. Sugar tolerance curve of M.C., aged 56. Histological No. 28899, June 15, 1936. Icterus index, 60.

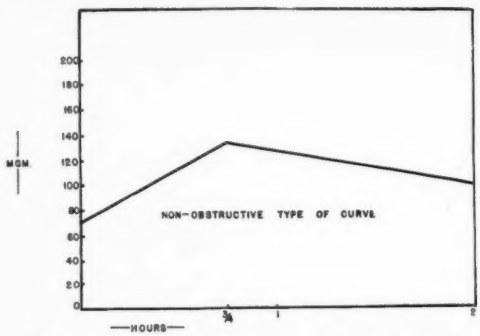

Fig. 2. Same case as in Figure 1, June 25, 1936. Icterus index, 16.

Six years previously he had been admitted to our hospital for an erysipelas infection of the face which responded to treatment.

Examination of the patient at the time of admission revealed a well developed and well nourished 56 year old male who was mentally confused. His temperature was 101 degrees; pulse, 80; respiration, 26; and blood pressure, 130/74. The patient was jaundiced and there was slight cyanosis of the lips and finger nail beds, but no dyspnea. There was a marked arcus senilis present. The pupils reacted normally to light and accommodation. The chest was emphysematous in appearance and râles were present at both bases. The heart was enlarged. The abdomen was distended and the liver enlarged to about four finger breadths below the costal margin with some tenderness and muscle spasm in the right upper quadrant. Both extremities showed pitting edema and absence of knee jerks. Icterus index on the day of admission was 60 and the sugar tolerance curve showed an obstructive type of reaction as shown in Figure 1. Fasting blood specimen was 84 milligrams of blood sugar per 100 cubic centimeters of blood. The 45 minute figure was 173 milligrams per 100 cubic centimeters of blood and the 2 hour specimen 200 milligrams per 100 cubic centimeters of blood. The patient received daily intramuscular injections of a 3 cubic centimeters ampul of liver extract and a high carbohydrate diet with 250 grams of glucose and insulin, 10 units twice a day. By June 25, 1936, patient showed a marked improvement. He was mentally alert and more co-operative. The icterus index had dropped to 16 and the glucose tolerance test showed a complete change from the obstructive to the non-obstructive type as shown in Figure 2. The fasting specimen was 73 milligrams sugar per 100 cubic centimeters of blood. The 45 minute specimen showed 133 milligrams per 100 cubic centimeters of blood and the 2 hour specimen was 100 milligrams sugar per 100 cubic centimeters of blood. The patient continued to show this marked improvement so that by July 2, 1936, he was able to be up and about.

Case 2. Patient F. H. H. N. 52872. Male, age 56 years was referred to the hospital on June 15, 1936 from the cardiac clinic where he had been in attendance since September 16, 1935. His symptoms of decreased cardiac reserve dated back about 2 years.

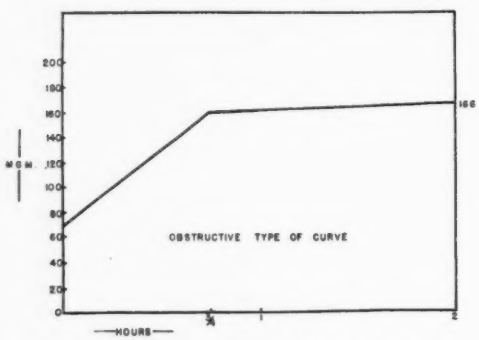

Fig. 3. Sugar tolerance curve of F.H., aged 56. Histological No. 52872, June 23, 1936. Icterus index, 16.

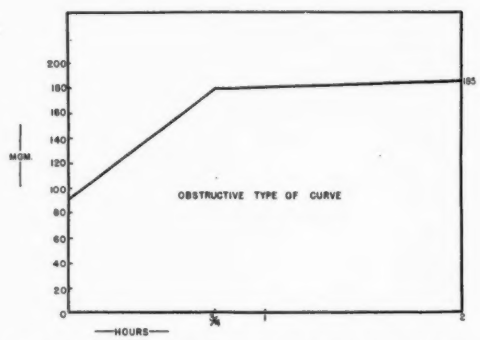

Fig. 4. Same case as in Figure 3. July 10, 1936. Icterus index, 29.

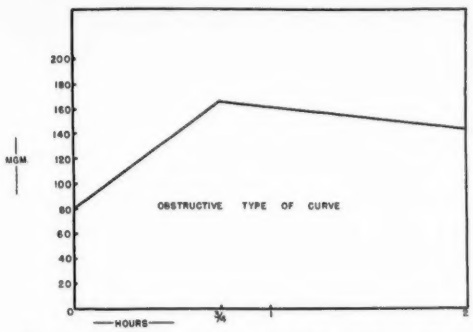

Fig. 5. Sugar tolerance curve on G.M., aged 40. Histological No. 53604, August 3, 1936. Icterus index, 100.

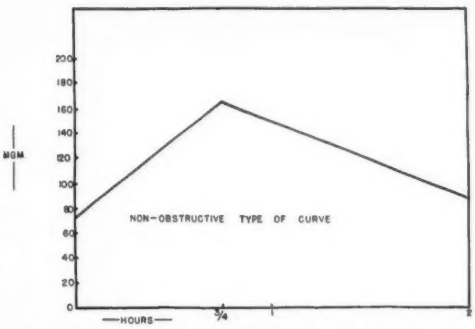

Fig. 6. Same case as in Figure 5, September 11, 1936. Icterus index, 50.

For 6 weeks prior to admission he had been receiving 4½ grains digitalis, every day, 2 cubic centimeters of mercuperin every week, and 5 grains of theocin four times a day, together with bed rest at home. During this period he gained 13 pounds without any improvement in his general condition.

On admission to the hospital his temperature was 99.6 degrees; respiration, 28; pulse irregular with a pulse deficit of four; blood pressure, 130/100. The patient showed all the signs of congestive failure secondary to an auricular fibrillation with dyspnea and cyanosis, râles at both bases, and marked ascites and peripheral edema. Abdominal paracentesis yielded 5,000 cubic centimeters of opaque amber colored fluid. On June 18, 1936, the icterus index was 16.0. The jaundice at that time was considered on the basis of a chronic passive congestion of the liver secondary to a cardiac decompensation. Intensive measures to combat the cardiac decompensation showed some signs of improvement but in spite of this the patient's icterus index increased to 29. A sugar tolerance test performed on June 23, 1936 showed a typical obstructive curve (Fig. 3) with fasting blood sugar of 70 milligrams per 100 cubic centimeters of blood. The 45 minute specimen was 160 milligrams and the 2 hour specimen 166 milligrams per 100 cubic centimeters of blood. The patient received 3 cubic centimeters of liver extract intramuscularly every day with high carbohydrate diet, 250 grams of glucose and 10 units of insulin twice a day. On July 10, 1936, the sugar tolerance test still showed the presence of an obstructive curve (Fig. 4), with fasting specimen, 95 milligrams per 100 cubic centimeters of blood; 45 minute specimen, 180 milligrams; and 2 hour specimen 182 milligrams per 100 cubic centimeters of blood. A diagnosis was therefore made of carcinomatous involvement of the liver. The patient continued to grow progressively worse, and died on July 10, 1936. An autopsy was performed which showed the presence of a primary carcinoma of the liver.

CASE 3. Patient, G. M. H. N. 53604. Female 40 years of age, admitted to the hospital July 31, 1936. For 1 year prior to admission patient had been having intermittent attacks of indigestion and last April, two of these were accompanied by severe pain in the right lumbar region which radiated to the right costal border. Two months ago patient noticed itching and 5 weeks ago she noticed that she was jaundiced. These symptoms have steadily increased. The onset of the present symptoms were not associated with any attacks of pain, and this was the first time that the patient noticed that she was jaundiced. There had been no vomiting and her bowels were constipated, for which she was taking saline cathartics. Patient stated that she did not notice any relation between her meals or fat intake and the attacks of indigestion. She also stated that as a child she had had attacks of indigestion which were diagnosed as due to "liver trouble." She was married and had been through two normal pregnancies. There were no other significant facts in her history.

Examination revealed a well developed and well nourished female, markedly jaundiced and showing numerous scratch marks as evidence of her itching. The heart and lungs were normal. The abdomen

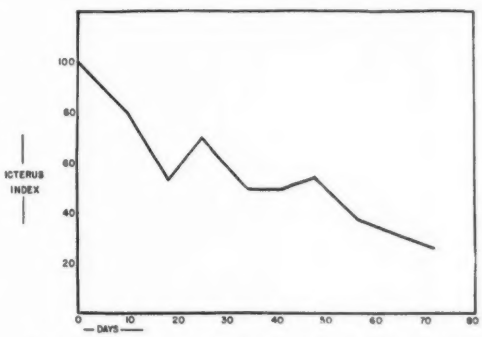

Fig. 7. Icterus index curve on same case as in Figures 5 and 6.

was slightly full and the liver palpable below the costal margin. There was some tenderness in the right upper quadrant. There was no temperature. Attempts to visualize the gall bladder with the dye were unsuccessful. The icterus index, August 1, 1936, was 100 and the sugar tolerance curve, August 3, 1936 (Fig. 5), showed an obstructive curve with the fasting specimen 80 milligrams, 45 minutes 166 milligrams and 2 hours 141 milligrams. The majority of the opinions expressed at the time seemed to favor the diagnosis of obstructive jaundice due to stone in the common duct. The picture, however, was not quite clear cut and on August 6, 1936, the patient was started on liver extract intramuscularly, together with 250 grams of glucose and 20 units of insulin daily. The course of the icterus index in this case during the period of treatment is shown in Figure 7. On September 10, 1936, the icterus index had decreased to 50 and the sugar tolerance curve (Fig. 6) performed the next day showed a change from the obstructive type mentioned above to a non-obstructive type. The fasting blood sugar was 74 milligrams the 45 minute specimen was 143 milligrams and 2 hours was 90 milligrams. The patient seemed so much improved that it was decided to see what she would do without the liver, glucose, and insulin. One week later the icterus index was repeated, September 17, 1936, and found to be practically unchanged at 52. The therapy was then resumed on September 22 and on October 5 the icterus index had dropped to 39. The patient insisted upon going home and there continue with her treatment. A follow up determination of her icterus index on October 14, 1936, showed a further drop to 29.0, and the patient showing marked improvement in her general condition.

These representative cases demonstrate clearly the response obtained in disturbed structural changes of the liver to the administration of liver extract, insulin, and glucose over a period of at least 2 or 3 weeks. All 3 cases showed the presence of jaundice with an obstructive type of sugar tolerance curve at the time of admission to the hospital. The first case showed at the end of the 2 week period a change in the sugar tolerance curve to the non-obstructive type with a decrease in the degree of icterus. This reaction has been obtained thus far only in cases of jaundice associated with cirrhosis or benign fibrosis of the liver. In Case 2, no such change or reversal of the sugar tolerance curve took place. Both at the beginning and end of the period of treatment with liver extract, insulin, and glucose, the sugar tolerance curve remained of the obstructive form. This fact together with the history and clinical course prompted us to classify this case as one of carcinomatous infiltration of the liver. Our opinion was confirmed by necropsy findings. In the third case the clinical picture could very well be interpreted as one of jaundice due to calculus obstruction. In fact that was the opinion expressed by several of the physicians who studied the case. The presence of an obstructive type of sugar tolerance test obtained at the time of admission could be consistent with both calculus obstruction and disturbed structural changes of the liver. It was certainly advisable to delay operation for a while in order to make this differential. After a 3 week period the icterus index decreased from 100 to 50 and the sugar tolerance curve changed to a non-obstructive type. The patient continued to improve and at the time of her discharge her icterus index had decreased to 39. A follow up, 9 days after discharge showed an icterus index of 29. The height of the icterus index is apparently of no assistance in differentiating between these conditions.

It must also be mentioned that the possibility always exists of both calculus formation and structural liver damage occurring in the same case. Our further work may add additional observations on this point. Where the differential diagnosis to be made happens to be between calculus obstruction and carcinoma of the liver, the above procedure is of no help since in both conditions neither the degree of icterus nor the type of sugar tolerance curve is effected by the liver extract, glucose, and insulin therapy. The obstructive sugar tolerance curve obtained in both the calculus obstruction and carcinoma of the liver cases would necessarily indicate surgical intervention. There is so little to be lost, however, by operating on such a hopeless condition as carcinoma of the liver that this possibility can hardly be considered as a serious drawback, when compared with the useful information which the above differential procedure affords.

CONCLUSIONS

1. Cases of jaundice which give the so called obstructive type of sugar tolerance test can be further classified.

2. In cases of benign structural damage of the liver, as cirrhosis, the daily use of liver extract, 250 grams of glucose and 20 units of insulin, results in a gradual decrease in the jaundice and a change in the sugar tolerance curve from "obstructive" to "non-obstructive."

3. This same response is not obtained in carcinoma of the liver, or in obstructive lesions of the common duct.

THE FALLACY OF THE USE OF IODINE IMMEDIATELY AFTER BILATERAL SUBTOTAL THYROIDECTOMY

A Preliminary Report

MARSHALL DAVISON, B.S., M.D., F.A.C.S., and LEON J. ARIES, M.S., M.D., Chicago, Illinois

THE dramatic demonstration of the use of iodine in exophthalmic goiter by Plummer in 1923 was an epoch in the surgical treatment of toxic goiter. The rapid improvement in the condition of these patients when treated by iodine, and the comparative safety with which they may be operated upon, has greatly widened the field of thyroid surgery, but, as in other progressive steps in medicine, its use has in some hands become indiscriminate and empirical.

It has been the opinion of one of us (M.D.) that the use of iodine after operation in patients who have had proper pre-operative iodinization was an unnecessary procedure. Nothing in the experimental or clinical literature has shown any chemical or physiological reaction between iodine in any form and thyroxine, once the thyroxine has reached the circulating blood stream. Conversely it is an established belief that the improvement in toxic patients is due to a diminution in the thyroxine content in the systemic circulation due to local control in the gland itself exerted by iodine, in mechanically diminishing the amount of thyroxine allowed to escape from the gland.

If this be true, the use of iodine in the immediate postoperative course of the patient following bilateral subtotal thyroidectomy has no therapeutic foundation and is an illustration of the empirical basis to which this form of iodine administration has developed. The routine of postoperative therapy has become so established that its continued use has gone on without question.

The end to which the use of iodine after operation is aimed is the protection of the patient against an undue postoperative thyrotoxic reaction, varying from a so called stormy course to a true thyroid crisis. If a patient has been adequately iodinized before operation and if a sufficient amount of gland has been surgically removed, it does not seem to us that postoperative reactions can occur from the thyroxine secreted by a small amount of residual gland, even allowing for the escape of a certain fraction of iodine from the gland. It would seem that the varying postoperative thyroid reactions, then, are due to the varying amount of thyroxine which is mechanically forced into the circulation during operation, and hence cannot be affected by the administration of any quantity of iodine. Clinically we have long known that the danger of reactions in surgically treated patients is greatly intensified by inadequate preparation or by operation before the time of optimum improvement.

With these ideas as a basis, the following experiments were carried out:

One hundred consecutive patients with hyperthyroidism, irrespective of type, were taken from the medical services of the Cook County Hospital and the University Hospital

From the Department of Surgery, Northwestern University, and the Surgical Service of Dr. Marshall Davison at Cook County Hospital and the University Hospital.

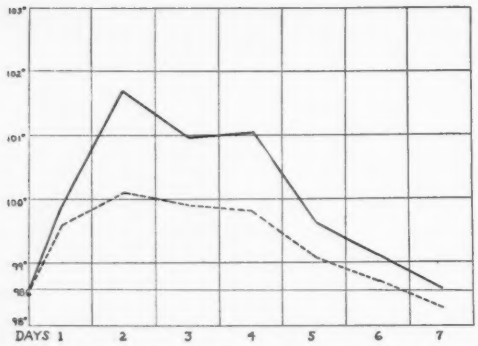

Chart 1. The unbroken line represents the highest daily postoperative average temperature of the 50 patients in series A (receiving iodine). The broken line represents the average daily lowest temperature in this series.

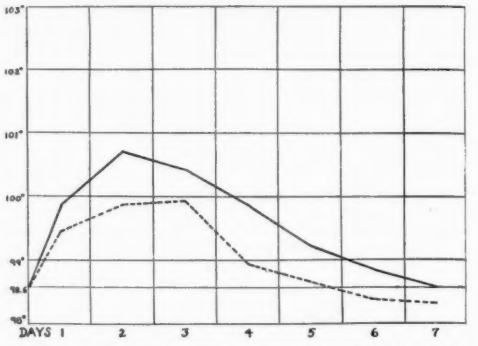

Chart 2. The unbroken line represents the highest daily postoperative average temperature of the 50 patients in series B (receiving no iodine). The unbroken line represents the average daily lowest temperature in this series.

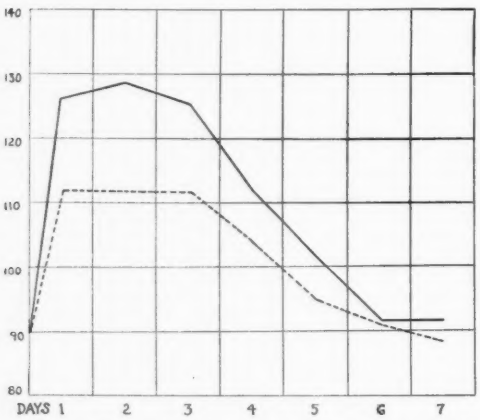

Chart 3. The unbroken line represents the average highest daily postoperative pulse rate of the 50 patients in series A. The broken line represents the average lowest daily pulse rate in this series.

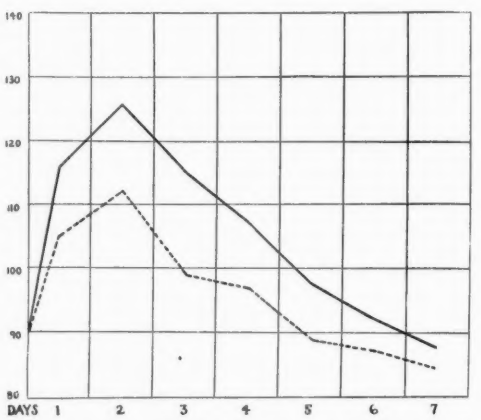

Chart 4. The unbroken line represents the average highest daily postoperative pulse rate of the 50 patients in series B (receiving no iodine). The broken line represents the average lowest daily pulse rate in this series.

TABLE I.—SUMMARY

	Series A	Series B
Average highest basal metabolism rate	39.7	43.9
Average lowest basal metabolism rate	20.9	18.0
Average days on Lugol's	17.6	18.5
Average age	40.7	38.5

after having been carefully prepared by iodinization and supportive treatment.

In all of these patients the classical operation of bilateral subtotal thyroidectomy was done in one stage.

Fifty patients comprising series A were given Lugol's solution after operation as in the usual procedure; rectally in a dosage of 1 dram immediately upon the return from the operating room, and from that day on by the oral administration of 10 minims three times daily. This amount is greatly in excess of that required for iodinization. A second group of 50 patients, comprising series B, were given no iodine in any form after operation. Other than this exception—the routine postoperative treatment was exactly the same as used in series A, consisting of a minimal amount of 2000 cubic centimeters of 10 per cent glucose given intravenously in

each 24 hours for 2 days, and morphine grain 1/6 administered as was found necessary for restlessness.

The postoperative course of both series was judged by the temperature, pulse, respiration, and the general toxicity of the patient, on the basis of 1 to 4 plus. The average highest and lowest daily temperatures were plotted (Charts 1 and 2). The average high and low pulse rates for each day were charted in a like manner (Charts 3 and 4). Further to compare the two series, the average basal metabolism rates on entrance and after preparation, as well as the number of days on iodine are recorded. The age of these patients ranged from 16 to 63 years in each series (Table I). As may be seen from the above charts the 2 series are fairly comparable as to average original metabolic rate, average reduction in the rate following the preparation with iodine, and the average number of days necessary to accomplish the optimum pre-operative improvement. We were prepared at all times to administer iodine in the form of intravenous sodium iodine to any patient whose reaction seemed unduly severe, but in no case did this become necessary. Even in instances in which the temperature and pulse rate rose disproportionately the administration of continuous intravenous glucose, by dilution produced a steady fall in the temperature and pulse and a general steady improvement in the toxic reaction of these patients. Those patients in series A who developed equally high temperature and rapid pulse rates did not respond any more rapidly to iodine and intravenous glucose than did those patients in series B who were given glucose solution only.

CONCLUSIONS

It would seem from this comparable series of cases that the following conclusions may be drawn:

1. Patients in series B to whom iodine was not administered after operation had an average milder reaction than those in series A who were given iodine.

2. Patients in series A who developed postoperative toxic phenomena did not seem to be influenced any more rapidly by the use of iodine, whether given intravenously or by mouth, than those of series B who were not given iodine.

3. From the above facts it would seem that the proper attack upon untoward reactions following bilateral subtotal thyroidectomy is dilution of the thyroxine in the circulating blood stream by the administration of enteral or parenteral fluids.

4. Toxic reactions must be proportional to the degree of pre-operative preparation of the patient, and consequently to the amount of thyroxine delivered into the blood stream at the time of operation.

5. There is no combination clinically shown to exist between iodine and thyroxine in the circulating blood.

6. If sufficient gland has been removed, and if the patient has been adequately prepared before operation, the use of postoperative iodine seems to have no rational basis.

7. In consideration of these factors the use of iodine is still definitely indicated in such incomplete operations as polar ligations, lobectomy, and the removal of discrete adenomas, in all of which cases residual thyroid tissue has been left behind, necessitating further protective iodinization.

ARTIFICIALLY INDUCED THROMBOPHLEBITIS

With a Suggested New Approach to the Problem of Postoperative Pulmonary Embolism

DAVID H. PATEY, M.S., F.R.C.S., London, England

THE problem of pulmonary embolism may be attacked from two aspects, the prophylactic and the curative. The cure of a case of pulmonary embolism by operative removal of the thrombus from the pulmonary artery furnishes probably the most dramatic triumph of the mechanical art of surgery. But the main problem it hardly touches. On the other hand, our knowledge of the factors determining the development of postoperative thrombosis is still too rudimentary to enable adequate prophylactic measures to be adopted to prevent such thrombosis. It is true that something can be done, the most hopeful line of approach up to the present being the encouragement of measures to prevent venous stasis. But pulmonary embolism still occurs. In this situation, it seemed to me that a new approach to the problem might be tried. And, briefly, the approach I would suggest is to recognize that in the present state of our knowledge it is impossible to prevent postoperative thrombosis, but to try to ensure that, should such thrombosis develop, the thrombus will remain fixed at its site of formation and not migrate. Then, though it may cause annoying sequelæ, they will not be tragic ones.

Generally speaking, the thromboses that occur after operation may be divided into two groups: those in which the phlebitic element is marked, and in these the signs are essentially obstructive, such as swelling of the leg and dilatation of collateral veins; and those in which the phlebitic element is not marked, and in these the first sign that a clot is present is often its migration. Now some light is thrown on the nature of the phlebitic element of thrombophlebitis by the changes that take place when a so called sclerosing solution is injected into a vein as in the treatment of varicose veins. It is, of course, well known that in a positive case two things happen: the vein lumen becomes filled with clot, and inflammatory changes take place in the vein wall and the surrounding connective tissues. There is thus the complete thrombophlebitic picture similar to that of the spontaneously arising condition. The reason for the production of the thrombus in the vein lumen under these conditions seems quite clear; the sclerosing fluid damages the vein wall and liberates a coagulating agent. The phlebitis at first sight is explicable in a similar way, as a direct reaction to the damage done to the vein wall by the sclerosing fluid. But while this no doubt plays a part in the inflammatory reaction, there are certain observations which make it unlikely that this is the whole story, or even the major part of the story.

For example, Figure 1 represents, diagrammatically, two common parallel observations. Figure 1, a, represents a large varicose vein with a marked regurgitant flow from above. If this vein is injected and the injection takes, the distended vein becomes filled with a large amount of thrombus and the phlebitic element is always marked. If the case is first treated, however, by proximal ligature to prevent regurgitant flow (as in Figure 1, b) the lumen of the vein is much smaller, the size of the thrombus is therefore much smaller, and corresponding with this the amount of inflammatory reaction in and around the vein wall is found to be much less marked. This is so in spite of the fact that in the type of case shown in Figure 1, b, the amount of sclerosing fluid injected is usually much greater than in the type of case illustrated by Figure 1, a. In other words, the phlebitic element is proportionate to the degree of distention of the vein in which thrombosis occurs and not to the amount of thrombotic agent injected.

From the Middlesex Hospital, London.

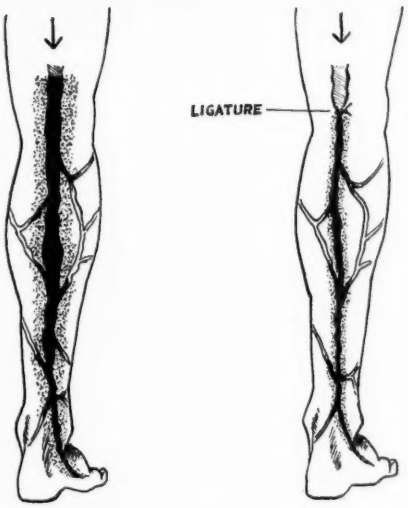

Fig. 1. a, left, Represents a varicose internal saphenous system with a marked superior reflux. Thrombosis occurring after injection in this case will be in a distended vein, and corresponding with this the inflammatory reaction (represented by stippling) in and around the vein wall will be marked. In b, right, on the other hand, the superior reflux is cut off by a ligature. Thrombosis therefore occurs in an undistended vein, and the inflammatory reaction will be much less marked.

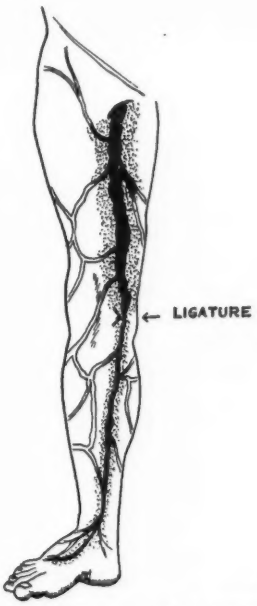

Fig. 2. This represents a similar internal saphenous system with a marked superior reflux. Ligature at the point indicated and injection peripherally will be followed by thrombosis with moderate phlebitis. If, however, spontaneous thrombosis occurs in the distended segment of vein above the ligature into which no injection has been made, the inflammatory reaction will be much more marked.

Figure 2 represents, diagrammatically, another common observation. If in a case of complete internal saphenous varicosity a ligature is tied around the vein about its middle, and an injection is made into the part peripheral to the ligature, thrombosis occurs in the distal part of the vein; and corresponding with the fact that the vein is collapsed from the cutting off of the regurgitant flow, the inflammatory reaction is slight. Frequently, however, thrombosis also occurs in the stagnant column of blood above the ligature into which no injection has been made. This part of the vein is dilated, since the regurgitant flow from above has not been cut off. The thrombus is therefore a large one, and corresponding with this the phlebitic element is marked, much more marked than in the case of the distal collapsed thrombosed vein into which the injection has been made.

Finally, if treatment has been by a ligature and injection and the patient is allowed to stay in bed afterward, sometimes when he gets up blood regurgitates through collateral channels into tributaries of the varicose system which have not been obliterated, and forms dilated pools; and if thrombosis occurs in these dilated pools the phlebitic element is more marked than in the main vein thrombosed in a collapsed condition.

The deduction from these observations would appear to be that the amount of phlebitic reaction is chiefly proportionate to the degree of dilatation of the vein in which thrombosis occurs and not to the amount of thrombosing agent injected.

If we now apply these facts to the problem of pulmonary embolism, clinical evidence already mentioned suggests that the phlebitic element in thrombophlebitis acts as a fixative of the thrombus and therefore as a preventive of pulmonary embolism; if we exclude the frankly septic thrombus, thrombi with a

marked phlebitic element rarely migrate. And since at present we cannot control or prevent the development of postoperative thrombosis, it would seem that another possible approach is to try to ensure that if thrombosis does occur, the protective phlebitic element is as marked as possible. If it be true that the amount of phlebitis is proportionate to the degree of dilatation of the vein in which thrombosis occurs, then our object should be to keep the veins of the lower limb, the usual source of postoperative pulmonary emboli, as dilated as possible. This can be achieved quite simply by raising the head end of the bed after operation and thus ensuring that the legs are the most dependent part of the body, when gravity will keep them filled.

There are two possible objections to this course. In the first place, it might be argued that a shocked patient would not be able to stand the head end of the bed being raised, and that in any case it is undesirable that a patient should be put into this position immediately after a severe operation. There is force in this argument, and on general principles it would appear advisable not to adopt a routine raising of the head end of the bed until 12 to 24 hours after operation. Second, it might be argued that placing the lower limbs in a dependent position would cause venous stasis, a known predisposing factor in thrombosis. If, however, a hard pillow is placed below the feet, the patient automatically tends to press against it in order to counteract the tendency to slip down the bed. And the resulting tonic action of the muscles probably more than counterbalances any stasis induced by gravity. In actual fact, experience of treating patients in this position after operation during the past year has revealed no serious practical objection.

SUMMARY

Experience of thrombophlebitis induced by sclerosing agents shows that the phlebitic reaction in thrombophlebitis is proportionate to the degree of distention of the vein in which it occurs. Experience of spontaneously occurring thrombophlebitis, on the other hand, shows that a marked phlebitic reaction is a protection against the thrombus migrating. Since we cannot control the development of postoperative thrombosis, therefore, we should try to ensure that it takes the less virulent local obstructive form rather than the migrating embolic form. It is suggested that this might be achieved by raising the head end of the bed 6 to 9 inches as a routine after those operations on adults which are particularly likely to be followed by pulmonary embolism, and keeping it raised until convalescence. In view of the blank walls reached in other directions in the attempted prophylaxis of pulmonary embolism, the carrying out of this simple measure on a large scale would be a legitimate clinical experiment.

THE CLOSTRIDIUM WELCHII AND ASSOCIATED ORGANISMS

A Review and Report of 43 New Cases

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SINCE the World War and especially during the last 5 years, surgeons have published many articles relating their clinical experience with gas gangrene. In addition, the Clostridium welchii has been the subject of numerous investigations. The mass of information thus accumulated has not been thoroughly reviewed; it seemed worth while to survey these data and summarize them briefly. In addition, a statistical analysis of 349 cases reported from 1930 to 1936 is included. This period was chosen because Millar already collected the 607 cases reported from the beginning of the post-Lister period to 1930; again it was felt that by limiting the cases to those of the last 6 years, one should obtain a more accurate impression of the subject of gas gangrene as it exists today, perhaps influenced by modern high speed transportation and industrial machinery. Finally, 43 additional cases are reported from the University of Pennsylvania and Philadelphia General Hospitals.

BACTERIOLOGY

The most common etiological organism in gas gangrene is the Clostridium welchii. There have been at least 25 varieties of anaerobic organisms isolated. Three of these are the common ones. From 80 to 90 per cent are the Clostridium welchii, at times termed welchii, Bacillus aerogenes capsulatus, Bacillus perfringens, and Bacillus phlegmonis emphysematosæ. The Clostridium œdematis maligni or Vibrion septique comprises from 10 to 28 per cent whereas the Clostridium novyi often spoken of as Bacillus œdematiens or Bacillus bellonensis accounts for only from 5 to 35 per cent. Much less commonly the Clostridium hystolyticum, Bacillus enteritidis sporogenes, Bacillus protems and Bacillus fallax are encountered. During the World War the Clostridium œdematis maligni and Clostridium novyi were also found in an appreciable percentage of cases. However, in civil life the incidence of these organisms is much less frequent. In the 139 instances where the organism is reported in the collected cases, the Clostridium welchii was present 132 times, Clostridium œdematis maligni and Clostridium novyi 4 and 3 times, respectively. Whether this is the true status or whether cases occur in which thorough bacteriological investigation is not the rule is a debatable question.

The Clostridium welchii is a gram positive spore forming anaerobe. Though it will not grow in the presence of free oxygen this organism and Clostridium enteritidis sporogenes are two of the less strict anaerobes. The presence of a capsule is a distinguishing feature. It causes foamy fermentation of litmus milk and grows best in a slightly alkaline medium, although producing acid itself. In culture there is a tendency to die out unless there is present an excess of alkali, such as calcium. Gas gangrene can be produced experimentally in mice, guinea pigs, and rabbits. They are highly resistant, however, if calcium is included in the injected cultures.

The desirability of rapid means of identification is self evident. In order to accomplish this some authors have suggested the injection into animals (mice and rabbits), sacrificing the animals after 30 minutes and incubating for 6 hours. The danger of false positives is quite apparent when one realizes the wide distribution of this organism in nature.

Cultures from the battle field of France, as well as from the uniforms returning from the trenches were 100 per cent positive. Cultures taken from war wounds in the year 1916 were reported 81 per cent positive. Even after the

wounds had passed through a casualty clearing station the report was 23 per cent positive. In civil life chronic leg ulcers have shown 34.3 per cent positive, normal intact skin 7.6 per cent positive, and some writers state that it is a normal inhabitant of the human and animal intestinal tract.

It has been isolated from samples of milk, water (spring), shell fish, cheese, flour, wheat, barley, rice, oatmeal, gunwads, wool, air, canned sausages, lettuce, potatoes, rice pudding, etc.

It has been cultured from the mouths of newborn infants, normal salivary glands, pancreas, normal urine and the vagina, and from the circulating blood in puerperal sepsis, chorea, and typhoid fever as well as in other diseases in which injury of the intestinal mucosa occurs.

Some investigators have even stated that the injection of sterile saline solution under these conditions will give positive results after incubation. The almost universal incidence of the organism makes a purely bacteriological diagnosis of gas gangrene unreliable. For example, Roberts, Johnson, and Brickner were able to cultivate it from the skin of 21.7 per cent of unprepared abdomens; 8.5 per cent of knife blades used in making skin incisions, and in 9.2 per cent in the peritoneum when opened for non-inflammatory conditions. One sees, therefore, that the finding of the Welch bacillus *per se* is meaningless. It is very important to bear this fact in mind when diagnosing gas gangrene and in comparing results obtained in their presence.

PATHOLOGY OF GAS GANGRENE

In the gas phlegmons, or gas edema, the musculature is much involved, although other tissues, such as subcutaneous fat, are not absolutely immune. This is especially true if the vital forces are at a low ebb as result of shock or debilitating disease. The muscles are saturated with gas bubbles (carbon dioxide from the muscle glycogen), become discolored, then necrotic, soft and waxy with laminated destruction, then soft and fluid, until finally they become a pulp filled with gas bubbles. There may be combined with this an edema of varying degree in the interstitial tissue which becomes cloudy and, following hemolysis, red in color; microscopically there are innumerable bacilli, fibrin, and leucocytes in the edematous mass. When a thigh is the site of gas edema, the swollen, pale skin feels cold to the touch and if the musculature is cut through crepitation is noted. This is a decomposition necrosis, the gases (carbon dioxide) arise from the action of the gas bacilli on the necrotic tissue. When pieces of earth infected with various anaerobic organisms and spores of many other kinds of bacteria are carried into the tissues, it is not surprising that a mixed infection appears, in which pathogenic anaerobes of various kinds mingle with saprophytic decomposition organisms and pyogenic bacteria. This accounts for the varying pictures: that of a markedly phlegmonous suppurative process with or without decomposition, or a predominant edema or a non-putrid necrosis with gas formation without odor or foul decomposition with foul smelling gas formation. The differences are expressed in the nomenclature so frequently used, such as gas edema, gas phlegmons, gas gangrene, etc.

The important single factor in the production of gas gangrene is not contamination with the organism *per se* but rather a suitable soil in which it can grow. Deeply lacerated and contused wounds, hematomas and compound fractures offer particularly favorable sites for the development of gas gangrene. Devitalized tissue and absence of oxygen favor rapid growth of the gas bacilli. The destruction of blood supply to a part, whether by trauma or occlusion i.e., diabetic gangrene, affords ideal conditions.[1]

The path for spread of the infection follows muscle bundles. The muscle first loses its staining reaction and completely degenerates ultimately. Such destruction of tissue precedes actual invasion of the tissue by the organism. The swelling of fibers within the muscle sheath strangulates it and furnishes the ideal environment for the growth of the welch bacillus. Though muscle is the tissue most commonly involved in the gas phlegmon, other tissues, such as subcutaneous fat, are

[1]The above pathological description is almost a verbatim quotation from Kaufman's Pathology, Reimann—vol. 31, p. 2042-2044.

not absolutely immune. This is especially true if the vital forces are at a low ebb as result of shock or debilitating disease.

DIAGNOSIS AND SYMPTOMATOLOGY

The diagnosis is not difficult in fully developed cases if the possibility of the condition is borne in mind. All individuals with severely contused wounds and compound fractures as well as those who have had amputations for diabetic gangrene, should be examined closely for evidence of gas bacillus infection. The characteristic "mousy odor," khaki discoloration of the skin, brownish discharge, unexplained severe pain and pulse rise out of proportion to the temperature, are practically pathognomonic. If local crepitation is added to these symptoms, the diagnosis is established, though it should be confirmed by the bacteriological laboratory. The mental alertness of the individual should not make one too optimistic as this is often the case *in extremis*.

Early diagnosis is essential for low mortality. Considerable aid can often be obtained from the roentgenogram. Rhinehart (Table I) has clearly shown its advantage in making the diagnosis of gas gangrene before it is clinically apparent. In suspected cases roentgen examination every sixth hour has been recommended. The x-ray not only affords assistance in diagnosis but it will frequently show the extent of the disease and give the surgeon valuable aid in determining the surgical procedures required. This gas must be differentiated from air forced into the tissues by muscle action following an injury or occasionally from the use of hydrogen peroxide as an antiseptic. Such differentiation is possible; Saville even states that one is able to differentiate the type of gas producing organism concerned. The presence of gas in the tissues from bacterial action, though usually due to one of the clostridium group, may, under favorable conditions, be caused by other organisms, especially the colon bacillus.

SUMMARIZED DATA FROM THE LITERATURE

Influence of trauma. The great proportion of gas gangrene followed accidental trauma.

TABLE I.—VALUE OF X-RAY IN EARLY DIAGNOSIS—FROM D. A. RHINEHART

	Diagnosed clinically 19 Cases	Diagnosed by x-ray 11 Cases
Shortest time	12.0 hours	2.5 hours
Longest time	75.0 hours	72.0 hours
Average time	50.5 hours	18.8 hours
Mortality per cent	52.5	18.2

Two hundred and twenty-two cases have been collected from 1930–1936. These cases occurred in the city as well as in rural districts, in the East as well as in the West. The reports of cases of gas gangrene are world wide, appearing from Australia, the Philippines, South Africa, Europe, South America, Canada, and practically every state in the Union.

Sixty-seven of these involved the upper extremity, with 10 deaths, 14 per cent; 33 of the 67 were treated by amputation, with 3 deaths, 9 per cent. This low mortality record is contrary to the opinion expressed by Maes who says that he never saw a case recover following amputation of the arm. The most frequent site of infection was the lower extremity in 106 cases with 25 deaths and 23 per cent mortality; 38 required amputation with 12 deaths, 31 per cent.

The amount of contamination at the time of the trauma has a definite influence upon the likelihood of development of gas gangrene. Personal cleanliness must also be considered. This fact is substantiated by Boland's figures if one assumes that negroes are less cleanly than Caucasians. In Atlanta, in 80 cases of compound fractures occurring in negroes, 15, 19 per cent, developed gas gangrene; whereas in the same period, in 97 cases of compound fractures occurring in whites, 7 developed gas gangrene, 7+ per cent. Another fact which may have some bearing is the delay following injury in consulting a physician, which was probably greater among the negroes. This point was clearly brought out during the World War when the incidence and mortality of gas gangrene was directly proportional to the time between trauma and débridement of the wound.

Many and varied types of trauma have been noted as predisposing factors. In one series of 222 there were 84 compound fractures, 43 automobile accidents, 26 industrial accidents and lesser numbers of gunshot wounds, splint

TABLE II.—CASES FOLLOWING TRAUMA

	Serum+x-ray		Serum		No serum	
Mortality per cent	19		17		31	
	Amputation	Incision	Amputation	Incision	Amputation	Incision
Recovered	8	25	34	69	22	17
Died	6	2	10	11	8	10
Mortality per cent	42	7	22	13	26	37
Percentage requiring amputation	34		35		47	

wounds and even insect bites. It is an interesting fact that only 7 of this entire group occurred on the farm.

One is immediately impressed with the large number of instances in which an automobile accident is the predisposing cause, which alone results in 4 times as many cases as gunshot wounds; in Millar's statistics gunshot wounds ranked ahead of vehicular as the means of entry of the organism. The histories in the 18 cases resulting from a fall from a height are strikingly similar, the usual story being a fracture due to indirect violence with a puncture wound near the site of fracture through which the bone might or might not protrude. The ends of the bone when examined were found to be contaminated by soil. Fractures were reduced and the first sign was severe pain. On removal of splints, the surgeon usually was surprised to find the arm swollen and a brownish fluid discharging from the puncture wound.

The type of treatment given these cases is summarized in Table II. All deaths reported are included in the mortality, whether from the toxemia of gas gangrene or some complication such as pneumonia, streptococcic septicemia, embolus, etc. All cases in which patients received serum are indicated thus whether the amount received was regarded adequate or not. Instances in which no mention of serum was made were considered as receiving none.

INFLUENCE OF HYPODERMICS

Junghaus (1933) analyzed more than 60 cases of gas gangrene following hypodermic medication of all types of which only 4 survived. As a rule it was impossible to trace the gas bacillus to the hands of the administrator, nurse or doctor, skin of patient, needle, solution, or method of sterilization. In one instance it was traced to the solution, although only one individual developed gas gangrene in 5 or 6 injected. This again emphasizes the fact that in the absence of fertile soil the gas bacillus is relatively innocuous. The hypodermics contained various ingredients, i.e., caffeine, epinephrine, morphine, physiologic saline solution, etc. The most frequent site of injection was the thigh, 27 cases. There were 7 such cases in our collected series with 6 deaths; 3 had serum and the only recovery (hypodermoclysis under breast) was in this group. The sites of injection in this group were arm (2), thigh (3), and submammary region (2).

THE EYE AS AN ATRIUM

Walker (1934) collected 10 cases of panophthalmitis; all of which followed a foreign body and, peculiarly enough, all recovered. They were characterized by rapid onset of symptoms and severe pain. A bubble of gas could be seen on examination. They were treated by enucleation. Four cases have occurred between 1930–1936, only 1 patient receiving serum. The early recognition of the disease and the limitation to the eyeball probably accounts for recovery of all cases.

THE UTERUS AS AN ATRIUM

Patients affected following abortion or instrumental delivery show marked constitutional reaction. The patient is prostrated, with a rapid thready pulse and an extreme fall in systolic pressure. Restlessness and extreme pallor are noted. Toombs and Michelson reported jaundice in 50 per cent of the cases due to the intense hemolysis which more usually causes dusky purple suffusion of the skin. They found the red blood cell below 2,000,000 in 58 per cent of cases and hemoglobin below 60 per cent in 78.5 per cent of cases. A loss of 2,000,000 red blood cells in 24 hours is reported. A positive blood culture was present in 16 cases during life. In other types of infection due to the Clostridium welchii, positive blood cultures are rare.

The Welch bacillus is probably present in a larger percentage of cases of puerperal sepsis than is generally recognized. Wrigley found in 16 deaths from puerperal sepsis in St. Thomas Hospital, 6 with generalized gas gangrene as revealed by postmortem examination. Falls believes that in severe cases the infection is a mixed one, often associated with the streptococcus. Vaginal cultures in the prenatal clinic of the Research and Educational hospital were positive for Clostridium welchii in 4.8 per cent of cases; in the gynecological clinic, in 33.0 per cent of cases; no positive results were found in a small series of private patients. In order to have a virulent infection, Wrigley presents the following four postulates:

1. Organism must be introduced into the uterus.
2. Organism must find suitable (dead) material on which to grow.
3. Dead fetus must remain sufficient length of time.
4. Damaged maternal tissues must be exposed.

From 1930–1936 there were 21 cases reported, 7 were treated with serum with 2 deaths, a mortality of 28 per cent. There were 7 deaths, mortality 46 per cent, in the remaining 15 cases treated without serum. Furthermore, of 8 recoveries, 6 were reported by Falls, the diagnoses having been based largely on the finding of the gas bacillus; the majority ran a mild clinical course. The question of extirpation of the uterus has arisen but too few cases have been reported to formulate any conclusions.

GAS GANGRENE FOLLOWING CLEAN AMPUTATIONS

In 1923, Tanner first reported gas gangrene following amputations through an allegedly clean field. Since 1930 there have been numerous similar reports (52 cases) which are summarized in Table III; 32, 61 per cent, have followed amputations for diabetic gangrene. The mortality is exceedingly high, being 59 per cent for entire group, still higher, 75 per cent, in diabetics. Table IV summarizes the experience with gas gangrene following amputations at the University of Pennsylvania and Philadelphia General Hospitals where relatively high incidence of this complication is noted, 6.7 and 10 per cent. Wilson, of Boston, in 420 amputations reports an incidence of only 2.6 per cent. The difference, however, is at least partially explained in that only 8.5 per cent of his operations were for diabetic gangrene while in the authors' series 89.8 per cent diabetes was the underlying disease.

TABLE III.—GAS GANGRENE FOLLOWING AMPUTATION CASES COLLECTED FROM LITERATURE 1930–1936—INCLUDING AUTHORS' CASES

Original cause for amputation	Serum used			No serum used		
	Alive	Dead	Mortality per cent	Alive	Dead	Mortality per cent
Diabetic gangrene	5	11	68	3	13	81
Senile gangrene	4	4	50		1	
Buerger's disease	4			1		
Varicose ulcer and gangrene		1				
Thrombosis	1			1		
Frost bite	2	1	33			
	16	17	51	5	14	73

The question naturally arises as to what can be done to prevent this complication in these patients who are exceedingly poor risks under the most ideal conditions. Wright noticed an increase in incidence of gas gangrene complicating amputations in the Metabolic Division of the Philadelphia General Hospital from 8.2 per cent, 1926–1931, to 24.5 per cent during a period in 1932–1933. In these latter years spinal anesthesia was almost the only anesthetic used. Attacking the problem from this angle he cultured Clostridium welchii from the flatus passed following spinal anesthesia. Since then the rectum has been protected by a cotton filter and the incidence for the first several months after this procedure was instituted was nil.

A commission was appointed to investigate this problem in New York City and the conclusions were published in the *Journal of Bone and Joint Surgery*[1]. They suggested as the most likely means of infection inadequate preparation of the leg and the possibility of the Clostridium welchii being already present in

[1] 1931, 29: 577.

TABLE IV.—HOSPITAL STATISTICS

Philadelphia General

		Percentage
Total number of cases admitted to ward 1930–1935	3019	
Major amputations required	283	9.3
Total Welch bacillus infection following amputation	19	6.7
Deaths in infected cases	14	73.6

University of Pennsylvania Services B and C

Total number amputations major (1923 to 1935)

	Cases	Total
Diabetic	45	
Arteriosclerotic	12	
Buerger's	9	
Traumatic	7	
Embolic	5	
Frost bite	2	
Trophic	1	
Gas gangrene	2	83
Deaths		
Diabetic	18	
Arteriosclerotic	2	
Traumatic	1	21
Mortality		25%
Welch bacillus infection following amputations	9	
Percentage of post amputations infected		10+%
Mortality in infected cases		33.3%

the lymphatics. It was thought unlikely that the gas bacillus was carried into the wound by any fault of the operating room technique or from suture material. The suggestions offered were: (1) culture gangrenous area before operation and, if positive, give a prophylactic injection of serum; (2) culture muscle at site of amputation at time of operation; (3) guard against fecal contamination; (4) guard against exposing gangrenous area in the operating room; (5) never use a tourniquet; (6) guillotine type of operation preferable; (7) leave the stump open; (8) operate either at knee where few muscle bundles are exposed or midthigh where one has good blood supply.

INCIDENCE FOLLOWING SURGICAL PROCEDURES

The complication of gas gangrene has followed almost every type of surgical procedure. In addition to those listed in Table V, cases have followed tonsillectomy, mastoidectomy, nephrectomy, and prostatectomy. The great proportion of these cases follow either gangrenous appendicitis and gangrenous cholecystitis or an operation in which the field is contaminated with fecal contents. The usual site of infection is the tissue surrounding the incision. Probably in some of these cases the infection is terminal but in others the toxemia of actual gas gangrene is the direct cause of death.

Nason and Starr believe that it is a more frequent complication than is commonly thought stating that, "Failure to think of this complication and the consequent omission of pertinent bacteriological studies, may leave the surgeon mystified as to the actual cause of death." They believe that one should attempt identification of organisms in the following syndrome: "Within 6 to 12 hours after operation certain alarming signs may appear in a patient whose postoperative recovery has been proceeding satisfactorily. Blood pressure begins to drop slowly and steadily and pulse rate is accelerated correspondingly. The anxious, restless patient becomes semistuporous and finally lapses into coma. The skin and extremities are pallid, cold, and moist. Most striking phenomenon is the progressive increase in body temperature, reaching sometimes as high as 108 to 110 degrees F. The combination of very high fever and pale cold skin signified an extreme degree of peripheral vasoconstriction, but shock therapy produces little or no improvement. Death is similar to liver deaths of Heyd." These authors believe that this syndrome is due to the gas bacillus, although this has not yet been satisfactorily established.

In the 43 cases here reported from the Hospital of the University of Pennsylvania and the Philadelphia General Hospital, 34 followed amputations of which 23 occurred in diabetic gangrene, 3 in senile gangrene, 2 in Buerger's disease, 2 following trauma, and 1 secondary to embolus. Compound fractures preceded 5 occurrences. Of the 4 remaining, 1 occurred following operation for peptic ulcer, 1 after operation for gall-bladder disease, and only 1 after a gunshot wound; another was secondary to a severe soft tissue contusion.

Seventy-nine per cent of the cases seen in these 2 hospitals follow amputations through clean fields. This is not the experience in hospitals admitting a large number of industrial and automobile accidents, however.

The results (Table VI) parallel those in the literature. The mortality in cases following amputations, especially for diabetic gangrene, is exceedingly high. Some indication of the efficacy of serum therapy is shown in this group. Of the fatal cases the average duration of life in those treated with serum was 8¼ days, in those untreated, 3½ days. In a number of serum treated cases the gas gangrene appeared to be under control, death resulting from pneumonia, septicemia, etc.

Williams noticed the similarity between the clinical picture of gas gangrene, late peritonitis, and intestinal obstruction. He was also able to culture Welch bacilli from the vomitus in these patients. A therapeutic test was then attempted with the following results: in 1418 cases of acute appendicitis from 1919 to 1923, the mortality was 6.5 per cent. In a series of 256 cases in which 18 of the most severe were treated with antitoxin, the mortality was 1.17 per cent. Another control series of 111 cases in 1925 gave a mortality of 6.3 per cent. Almost similar results were obtained in intestinal obstruction. In a control series of 214 cases between 1919 and 1923, the mortality was 24.8 per cent. In a test series of 54 cases, 1924–1926, in which antitoxin was administered to 19, the mortality was 9.3 per cent. Clinical observation showed a decrease in restlessness and distention and general improvement in the patient following the use of antitoxin. Bower and Clark believed that they were able to confirm the work of Williams.

Experimental work that tends to substantiate this theory is that of Dragstedt in 1927 and Morton and Stabins in 1928. Dragstedt concluded that (1) closed intestinal loops in which bacteria are first removed are compatible with life; (2) closed intestinal loops in which bacteria are present but in which tissue necrosis is prevented are compatible with life; (3) closed aseptic intestinal loops in which the blood supply is completely occluded are compatible with life; (4) the normal secretions and bacterial products of the duodenum and jejunum are not sufficiently toxic to produce any symptoms when allowed to drain into the abdominal cavity; (5) bacterial activity plus necrotic tissue is the important factor in the rapid death in simple closed intestinal loops. Morton and Stabins produced obstruction 10 inches below the ligament of Treitz and allowed a well marked toxemia to develop. An operation was then performed to relieve the animal from the obstruction. Animals receiving Clostridium welchii antitoxin survived while those that received no antitoxin died.

However, much experimental work has been done to show that Welch toxin is not connected with the toxemia of intestinal obstruction. McIver, White, and Lawson, although they found the Clostridium welchii in enormous numbers in closed intestinal loops in the cast, were unable to prolong life, by the use of Welch antitoxin. North produced obstruction 6 inches above the ileocecal juncture in dogs and noticed no difference in length of life in those that received antitoxin and those that did not. Owings and McIntosh reached the same conclusion. Thurston, using dogs, concluded that: (1) Dogs suffering from a toxemia caused by acute intestinal obstruction are not helped by passive or active immunization to the toxins of Clostridium welchii. (2) Dogs with acute intestinal obstruction produce no immune bodies for these

TABLE V.—GAS GANGRENE FOLLOWING SURGICAL PROCEDURES

	Serum used		No serum used	
	Alive	Dead	Alive	Dead
Appendectomy	2	1	4	3
Herniorrhaphy		1		1
Enterostomy	2	1		5
Salpingectomy	1			1
Gall-bladder surgery	2	4	1	5
Resection of bowel				2
Open reduction simple fracture	1			
Incision ischiorectal abscess	1			3
Resection peptic ulcer			1	
Removal of sponge peritoneal cavity	1			
	10	7	6	20
	Mortality 41%		Mortality 76%	

TABLE VI.—END-RESULTS

	Cases	Deaths	Mortality per cent
Gas gangrene	43	22	51
Serum used	30	12	40
No serum used	13	10	77
Following diabetic gangrene	23	17	73
Serum used	12	8	66
No serum used	11	9	82
In fatal cases, length of life after injury			
With serum, 8¼ days			
Without serum, 3½ days			

toxins. (3) There is no evidence of the presence of the toxin of Clostridium welchii in the abdominal transudate or in blood from the mesenteric veins of dogs with acute intestinal obstruction. (4) No direct or indirect evidence that toxin of Clostridium welchii has any rôle in the toxemia of acute intestinal obstruction.

RELATION OF CLOSTRIDIUM WELCHII TO PERNICIOUS ANEMIA

An increase in the number of Clostridium welchii in the stools of patients with pernicious anemia and the marked anemia produced in acute infections of Clostridium welchii origin, suggested a possible relationship between Clostridium welchii and pernicious anemia. This, however, has been thoroughly disproved. Draper and Barach remark that "anemia due to Welch bacillus toxin no matter how administered over how long a period, shows the characteristics of a secondary anemia. The hemoglobin is generally more lowered than the red blood cells, resulting in a low color index. The smear shows a conspicuous absence of nucleated red cells, marked distortion in the shape of the cells, and a predominance of macrocytes. Anisocytosis and polychromatophilia are the outstanding findings. The anemia tends to disappear spontaneously notwithstanding the continued injection of toxin. The spinal cord does not show degenerative changes as seen in combined sclerosis and pernicious anemia. Immunity to the Welch toxin is quickly produced in the rabbit." They further state that "Sera of normal rabbits, normal individuals, patients with secondary anemia did not possess antihemolytic activity against Welch bacillus toxin. The series of pernicious anemia patients included instances of severe anemia as well as of remission." "The absence of specific Welch bacillus antihemotoxin in the pernicious anemia patients studied and its uniform presence in chronic Welch bacillus anemia in the rabbit suggests that these two anemias have a different etiologic mechanism."

RÉSUMÉ OF TREATMENT

Surgery is still the prime indication in most cases of gas gangrene, both as a prophylactic and curative measure. Early débridement of contaminated wounds will protect many patients from the Welch bacillus. The fundamentals in the treatment of soiled wounds is adequately summarized in the outline to the United States Medical Corps before the Battle of Chateau Thierry. These instructions were: to operate as soon as possible, to use nitrous oxide anesthesia, to employ longitudinal incisions half again as long as thought necessary, to avoid the use of tourniquets and injury to normal muscle, preserving all viable skin, to open wound thoroughly, all torn, crushed, and discolored muscle to be excised, all loose bone and foreign bodies to be removed, the wound to be left open, filled loosely with moist gauze and the part immobilized.

With the aid of serum more conservative surgery can and should be practised. A partially crippled leg or arm is better than an artificial one. There is one danger in recommending conservative surgery, viz.: where the blood supply to the part is destroyed. Traumatic cases of this type should be subjected to amputation without delay. One of the deaths in our series was attributed to failure to carry out this dictum.

Dakin's solution is the most popular of the antiseptics used. Its reaction is alkaline, however, and an occasional author will condemn it vigorously. With Clostridium welchii preferring a mild alkaline reaction a mild acid antiseptic might be better. Bulkey recommends the use of acetic acids. One wonders whether the hydrochloric acid in Pilcher's solution is not the active agent.

Some surgeons very strongly favor hydrogen peroxide while others oppose its use. It should logically be advantageous in creating an unfavorable growth medium. However, it has the possible advantage of forcing oxygen into the tissues which will confuse the attending physician in determining the progress of the disease. Potassium permanganate is another oxidizing agent very widely used. Some authors claim good results from bubbling oxygen through the wound. Others inject oxygen into the surrounding tissue to prevent spread; this also offers confusion in physical examination. The injection of foreign material proximal to the infected part might con-

ceivably interfere with the blood supply to the part.

The value of serotherapy seems to be well established. A summary of its results is found in Table VII. The results as shown in Tables II, III, V, and VI very definitely indicate the lowest mortality with serum therapy combined with conservative surgery. The value of serum as a prophylactic measure has not been as definitely shown. Statistics from the War (Table VII) would tend to show that it was useful. Insufficient data have been presented in the literature regarding its use in civil surgery to formulate any conclusions. At the present time perfringens antitoxin is being used prophylactically in both the Hospital of the University of Pennsylvania and the Philadelphia General Hospital. It is the authors' impression that the incubation period is longer and the clinical signs milder after a prophylactic injection of serum. One must guard against being lulled into a false sense of security because of this delay in development of the disease, however.

The use of the roentgen-ray is the latest form of treatment of gas gangrene. Kelly in a review article in 1936 is very enthusiastic. In 2 personal cases results have been satisfactory. One case which showed clinical, bacteriological, and roentgenological evidence of gas gangrene, was treated by the x-ray and serum. Though a diabetic she recovered promptly and left the hospital without the necessity of débridement of the stump. The other patient died within a week of streptococcic septicemia but at death there was no clinical evidence of gas gangrene.

In reading the histories of the fatal cases one is impressed by the large number that apparently survive the gas gangrene but die from some intercurrent infection or complication. Possibly the fear of the organism has been so universally instilled into all individuals taking care of gas gangrene that general nursing care is neglected. Certainly the need for strict isolation is not as pressing in a case of gas gangrene as in a hand infected by the streptococcus. We do not mean to imply that one should not use all precautions against transmission of organisms—rather do we strongly indicate that the nursing care of these patients is of utmost importance.

Blood transfusions should be given as indicated. If there is evidence of hemolysis, as shown by slight jaundice, a daily check should be kept on the condition of the blood.

TABLE VII.—RESULTS OF SERUM

Prophylaxis

Sacquépée 319 severely wounded, morbidity 1 per cent, control 7.2 per cent.
Two German Divisions—serum 0.3 per cent—control 3.0 per cent.
Maireose I—1.016 wounded—morbidity 0.3 per cent.
Gross—Early in 1916 wounded, no prophylaxis—3.6 per cent.

Treatment

Mortality in series without serum varies from 30 to 83 per cent.

	Serum Cases	Mortality per cent
Weinberg	60	6.7
Sacquépée	191	13.0
Vincent		14.8
Maireose		16.5
Rouvillos		30.0

	Mortality per cent
Millar collected from literature 99 cases with serum	39.4
Millar collected from literature 291 cases without serum	42.0

The authors have collected from the literature (1930–1936) a total of 349 cases of which 224 were treated with serum, with 56 deaths, a mortality of 25 per cent, and 125 were treated without serum, with 62 deaths, a mortality of 49 per cent.

SUMMARY

The Clostridium welchii is an organism widely distributed in nature, and good judgment must be used in attributing disease syndromes to it, when the organism may be simply an incidental finding. It is relatively avirulent, requiring an ideal environment to become pathogenic. This optimum growth medium is provided in dead tissue resulting from mangling injuries of high speed transportation and industrial machinery. Its anaerobic characteristics have been emphasized and oxidizing agents have been chosen as antiseptics.

Its relation to the toxicity in intestinal obstruction and peritonitis has not been definitely proved or disproved. One must await further investigation along this line. The anemia resulting from Bacillus welchii toxin is unrelated to pernicious anemia.

Early diagnosis is essential in the treatment of gas gangrene.

Serum therapy in addition to conservative surgery offers the best results. However, one should not hesitate to amputate in case of destruction of blood supply to an extremity. Although good results are reported from x-ray therapy, one is not justified at present in omitting serum therapy. The need of good nursing care to prevent complications is emphasized and supportive measures, especially blood transfusions, should not be neglected.

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DIFFERENTIATION BETWEEN PERIPHERAL ARTERIAL AND ARTERIOLAR SPASTICITY IN THE SELECTION OF CASES FOR SYMPATHETIC GANGLIONECTOMY

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THE differentiation between organic and spastic vascular disturbances of the extremities is of great importance in outlining the course of treatment of those conditions. A number of methods have been devised to determine this difference and for the selection of cases for sympathetic ganglionectomy, namely, the vasomotor index of Brown determined by producing an artificial fever, anesthetization of the sympathetic nerves going to an extremity (10), anesthetization of the peripheral nerves (6), spinal anesthesia (1), and more recently the method of reflex vasodilatation of one extremity by warming another as devised by Landis and Gibbon (4).

Theoretically all cases of peripheral vasospasm should be relieved by sympathectomy. The occasional reports of failure to relieve those symptoms and the recurrence of symptoms in others after anatomically complete sympathetic ganglionectomy suggest the possibility that there are several types of peripheral vasospasm. In none of the aforementioned tests is there an attempt made to differentiate between vasospasm which involves central overstimulation of the sympathetics and that which may be due to local peripheral changes. To study these differences and to develop a method for their differentiation was the purpose of this investigation.

METHODS AND OBSERVATIONS

Our first problem was to determine the types of arteries dilated by the various known methods of testing vasospasticity.

Other investigators have shown that any irritation of the skin, such as pinching or scratching, or the intradermal introduction of histamine causes a dilatation of the surrounding arterioles and capillaries (5). In a previous investigation (7), we demonstrated that measuring the temperature of the resulting flare is an accurate index of the degree of vasodilatation thus produced. More recently we demonstrated that further stimulation of the same area or the use of a stronger concentration of histamine did not increase the intensity of the histamine skin reaction, but only hastened its appearance and lengthened its stay. Thus, the temperature of the histamine flare is an excellent means of determining the presence and the degree of arteriolar dilatability. We determined to use this simple method of producing arteriolar dilatation in studying the types of vasodilatation produced by the other tests.

In all of the commonly used methods for differentiating between organic and vasospastic disturbances, the rise of the skin temperature in the area examined is the criterion for grading the dilatability of the vessels. We reasoned that if complete vasodilatation is produced in an extremity by any of these methods, further stimulation of some of the vessels locally should have no vasodilatory effect. Any further increase in the size of the vessels and any rise in the temperature of the skin following local stimulation would mean that complete peripheral vasodilatation was not produced by the method in question.

The method of determining vasodilatability by peripheral nerve anesthetization was first examined. In all experiments in this study the subject rested horizontally on a table for about one-half hour before the experiment was begun. The room temperature was between 20–22 degrees C. In a few instances when the room temperature was higher than 22 degrees C., all skin temperatures were corrected by subtracting 0.3 degrees C. for each 1 degree C. of room temperature difference (6).

From the Peripheral Circulatory Clinics of the Department of Surgery, Northwestern University Medical School, and the Michael Reese Hospital.

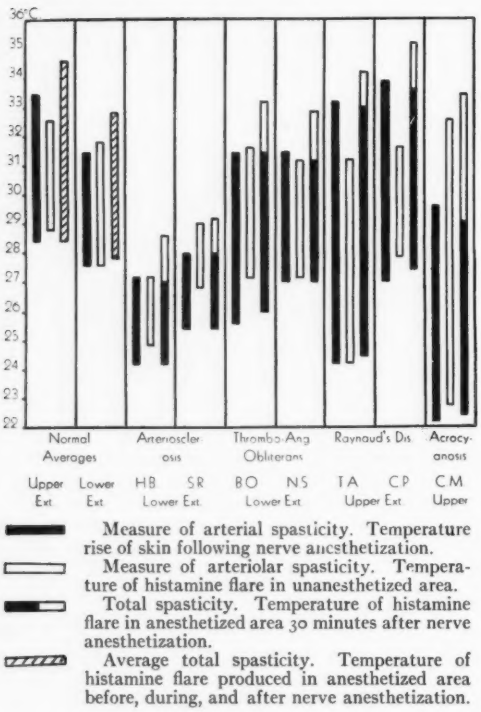


Fig. 1. Various combinations of arterial and arteriolar spasticity. Normal averages: Results in 3 normal brunet males. There is moderate arterial and arteriolar spasticity in both upper and lower extremities. Arteriosclerosis: Very slight arterial and arteriolar spasticity. Thromboangiitis obliterans: Moderate arterial and arteriolar spasticity. Raynaud's disease: Marked arterial and moderate arteriolar spasticity. Acrocyanosis: Moderate arterial and marked arteriolar spasticity.

The skin temperatures were taken with a mercury skin thermometer. The histamine skin test was performed in the extremities of normal individuals before, simultaneously with, and at the height of, the anesthesia produced in the tested skin areas. The temperatures of the histamine flares in these areas and in similarly situated unanesthetized control areas were recorded every 5 minutes. In the upper extremities the histamine skin tests were performed on the dorsum of the fifth finger and the skin was anesthetized by injecting 1 per cent procaine into the ulnar nerve at the elbow. A control histamine skin test was performed on the unanesthetized dorsum of the first finger. In the lower extremities the tests were performed on the dorsum of the first toe, and anesthesia was produced by injecting 1 per cent procaine into the peroneal nerve below the knee, the posterior tibial nerve at the ankle, and, when necessary, the saphenous nerve at the ankle. A control histamine skin test was performed on the unanesthetized lateral surface of the foot. The results in three normal individuals in whom these tests were performed in both the upper and the lower extremities are shown in Figure 1 (normal averages).

In each instance the removal of the central vasomotor influences by anesthetization of the peripheral nerves leading to any area caused a rise in the temperature of that area with only a very slight redness of the skin. The histamine skin test performed in the same anesthetized area caused a comparatively intense red flare to appear at the height of the reaction and a further rise in skin temperature. The temperatures of the flares in the anesthetized areas were 1.0 to 1.8 degrees C. higher than that of the surrounding skin, and 0.6 to 2.4 degrees C. higher than that of a flare in an unanesthetized area. The results were the same regardless of the time relationship between the histamine skin test and the production of anesthesia.

The rise in the skin temperature with only slight skin redness following nerve anesthetization and the production of a comparatively intense red flare and a further rise in the temperature in the same skin areas by local irritation with histamine prove that complete vasodilatation is not produced by peripheral nerve anesthetization. These results suggest (1) that removal of the central vasomotor influences causes a rise in the skin temperature by dilatation of the larger terminal arteries, and (2) that local stimulation of skin by histamine causes a rise in the surface temperature by dilatation of the arterioles and capillaries.

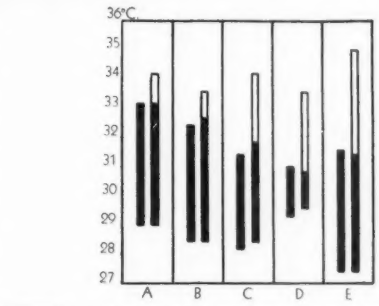
In order to check this concept further, similar experiments were carried out in normal individuals with different vasodilating tests. The tests included the following: anesthetization of the sympathetic ganglia; spinal anesthesia; foreign protein febrile reactions; and re-

flex vasodilatation of one extremity by heating another. In addition the histamine flare test was carried out in an individual who had a fever due to pharyngitis. The results are shown in Figure 2. The results were similar in each instance to those obtained in the aforementioned peripheral nerve anesthetization experiments. Complete peripheral vasodilatation was not obtained by any of the methods used. Each of the various procedures caused a rise in the skin temperature with some flushing of the skin, but local stimulation of the same skin area by histamine produced an intense red flare and a further rise in the skin temperature. These experiments support our hypothesis that there are two types of peripheral vasodilatability, one type controlled by central sympathetic stimuli and another controlled by a local mechanism.

A similar study was made with patients suffering from peripheral circulatory disturbances in order to determine the type of vasospasticity present in each. For this purpose 2 cases of senile arteriosclerosis, 2 cases of early thrombo-angiitis obliterans, 2 cases of Raynaud's disease, and 1 case of acrocyanosis were studied. In each individual the peripheral nerve anesthetization method of producing arterial dilatation was used. The histamine skin test was performed after complete anesthesia was obtained in the area tested, and also in control unanesthetized areas. The results are shown in Figure 1.

In the patients with arteriosclerosis there was only a slight rise in the skin temperature following both the nerve anesthetization (27.2 degrees C., 28.0 degrees C.) and the production of a flare in the unanesthetized skin (27.2 degrees C., 29.0 degrees C.). The highest temperature of a flare in an anesthetized area was 1.4 degrees C. above that of the surrounding skin. All the temperatures taken were far below the normal averages indicating marked circulatory impairment. Very little vasodilatation was produced by either the blocking of the central vasomotor stimuli or by the local stimulation of the skin with histamine. The circulatory impairment was obviously due to organic vascular changes.

The 2 cases of early thrombo-angiitis obliterans each had a moderate rise in the skin



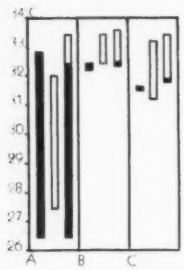
Rise in skin temperature produced by the vasodilating test.

Rise in skin temperature produced by the histamine skin test.

Fig. 2. Comparison of the vasodilatation produced by the commonly used tests alone and when combined with the histamine skin test. A, Anesthetization of the sympathetic ganglia. H.P., Angina pectoris, left stellate and second and third thoracic sympathetic ganglia anesthetized with 1 per cent procaine. Histamine skin test performed in 15 minutes. B, Spinal anesthesia. W.S.G., Hysterectomy, 200 milligrams of novocaine introduced intraspinally. Histamine skin test performed in lower extremity in 30 minutes. C, Foreign protein febrile reaction. M.C., Chronic prostatitis, 25 million killed typhoid bacteria introduced intravenously. In 8 hours the mouth temperature was 38.6 degrees C. Histamine skin test performed at 8 hours in upper extremity. D, Reflex vasodilatation of one extremity by warming another. C.R., Normal, lower extremities immersed in water at 45 degrees C. Histamine skin test performed in upper extremity in 30 minutes. E, Acute infection with fever. M.G., Acute pharyngitis, mouth temperature 39.6 degrees C. Histamine skin test performed in upper extremity.

temperature following the nerve anesthetization (31.4 degrees C., 31.4 degrees C.) and also when the histamine flare was produced in the unanesthetized skin (31.6 degrees C., 31.2 degrees C.). The highest temperature of a flare in an anesthetized area was 1.8 degrees C. above that of the surrounding skin. The original temperatures of the unanesthetized skin in these cases were very low and there were signs of organic vascular changes such as absence of pulsation in the various arteries. However, the rise obtained in the skin temperatures which reached the normal average in several instances, was evidence of concomitant arterial and arteriolar spasticity and the presence of adequate collateral channels.

In both patients with Raynaud's disease examined there was a marked rise in the temperature of the skin following nerve anes-



Rise in skin temperature produced by peripheral nerve anesthesia.

Rise in skin temperature produced by histamine skin test.

Rise in skin temperature produced by the combined tests.

Fig. 3. Comparison of the vasodilatation produced by the peripheral nerve anesthetization test and the histamine skin test before and after sympathetic ganglionectomy. D.S., Vasomotor disturbance of lower extremities with marked arterial and moderate arteriolar spasticity. A, Before lumbar sympathetic ganglionectomy. B, One day after lumbar sympathetic ganglionectomy. C, Six months after lumbar sympathetic ganglionectomy.

thetization (33.2 degrees C., 33.8 degrees C.), and a comparatively moderate rise in the temperature in the flares produced in the unanesthetized skin (31.2 degrees C., 31.6 degrees C.). The highest temperature of a flare in an anesthetized area was 1.4 degrees C. above that of the surrounding skin which was already elevated above normal. The skin temperatures obtained following nerve anesthetization were slightly higher than those obtained in the normal individuals even though the starting temperatures were much below normal. Our results indicated that in each of the cases there was both arterial and arteriolar spasticity. The greater temperature rise in the skin following nerve anesthetization than that produced by histamine flares in the unanesthetized skin, however, suggested that the spasticity of the terminal arteries, which was relieved by removal of the central vasomotor impulses, was more marked than the spasticity of the arterioles and capillaries, which was relieved by local stimulation with histamine.

In the case of acrocyanosis there was only a slight rise in the skin temperature following anesthetization (29.6 degrees C.), but there was a very marked and rapid rise in the temperatures of the histamine flares in the unanesthetized skin (32.6 degrees C.). The temperature of the flare in the anesthetized area rose 3.8 degrees C. higher than that of the surrounding skin. There was greater vasodilatation produced by local stimulation with histamine than by removal of the central vasomotor impulses.

We then examined an individual who was subjected to a bilateral lumbar sympathetic ganglionectomy for a vasomotor disturbance of the lower extremities without demonstrable organic changes in the blood vessels. This patient was studied by means of the peripheral nerve anesthetization and the histamine skin tests before operation, one day after sympathetic ganglionectomy, and 6 months after sympathetic ganglionectomy. The results are shown in Figure 3. The sympathetic ganglionectomy produced, on the following day, a rise in the skin temperature which was equal to that of the previous nerve anesthetization. Anesthetization of the peripheral nerve produced a marked rise in the skin temperature before the operation but failed to do so both 1 day and 6 months after the sympathetic ganglionectomy. The temperature of the toes remained elevated 6 months after the operation, but to a somewhat lesser degree than immediately after operation.

Prior to the sympathetic ganglionectomy, the histamine skin test caused a moderate temperature rise in the unanesthetized skin of the lower extremities, and when performed in an anesthetized area of skin in which the temperature was already elevated, it caused a still further rise. Following the operation the temperature of a histamine flare in the sympathectomized area was greater than that of the surrounding skin, and on both the first day following the operation and 6 months later the height of the temperature attained in the flare was as great as that in the flare in an anesthetized area before the sympathectomy.

Following the actual removal of the sympathetic pathways to the lower extremity, anesthetization of the peripheral nerves failed to produce further vasodilatation or to elevate the skin temperature, but stimulation of the skin locally with histamine did produce such a rise in the skin temperature, apparently by

causing dilatation of the arterioles and capillaries. These experiments bear out our contention that there are two types of peripheral vasospasm, that of the large terminal arteries which are controlled by the autonomic nervous system and that of the arterioles and capillaries which are controlled by a local mechanism.

EVALUATION

The sympathetic innervation of the blood vessels of the extremities consists of postganglionic sympathetic fibers originating in the thoracolumbar ganglia which join the peripheral nerves by way of the gray rami communicantes and are then distributed to the blood vessels segmentally (8). The final distribution of these fibers to the large and small arteries has been demonstrated by numerous investigators (3), but the innervation of the terminal arterioles and capillaries has never been definitely established. No positive proof of the control of the latter by the central or the autonomic nervous systems has been given.

The inability to produce complete peripheral vasodilatation by any of the known vasodilating methods or by complete removal of the sympathetic fibers leading to an extremity suggests that the autonomic nervous system does not completely control the dilatability of the peripheral arterial system. The rise in the skin temperature with only slight redness following removal of the sympathetic nerves is evidence that there is dilatation of the larger terminal arteries which must necessarily be controlled by the autonomic nervous system. The further rise in the temperature of these skin areas associated with marked redness, which is produced by a local irritant such as histamine, suggests that the dilatation of the skin arterioles and capillaries is not brought about completely, if at all, by removal of the central vasomotor impulses. This fact plus the demonstration by Smithwick, Freeman and White and others, that local vasospasm can be produced in sympathectomized extremities by appropriate stimulants in the bloodstream indicate that control of the arterioles and capillaries lies in some local mechanism, either nervous or chemical, which is not completely dependent, if at all, upon the autonomic nervous system.

Our experiments bring together the various theories of peripheral vasospasm and offer an explanation for the conflicting statements in the literature regarding the efficiency of sympathetic ganglionectomy in peripheral circulatory disturbances. Heretofore, the decision for performing a sympathetic ganglionectomy was made upon results obtained by the various methods of producing arterial dilatation. We have demonstrated that with none of the commonly used methods can one determine the degree of total vasospasticity in an extremity. We believe that the degree of arteriolar spasticity present will determine to a great extent the end-results following sympathetic ganglionectomy. It is possible that in some of the reported failures to relieve the symptoms of vasospasticity by a sympathetic ganglionectomy a high grade of arteriolar spasticity was present. We believe that the combination of the histamine flare test and peripheral nerve anesthetization offers a means of determining the degree of both arterial and arteriolar spasm.

To determine the type and the degree of vasospasticity in the upper extremity we carry out the following procedure: The hand is exposed on a table at about heart level in a room at 20 to 22 degrees C. atmospheric temperature. The skin temperature of the dorsum of the fifth finger is then taken every 5 minutes until it remains at a constant level. A small amount of histamine solution (1:2000 histamine in ½ per cent procaine) sufficient to make a wheal of about 2 millimeters in diameter is injected intradermally on the dorsum of the finger and the temperature of the resulting flare recorded every 5 minutes until it has reached its height (15 to 20 minutes). The ulnar nerve is then anesthetized at the elbow, behind the medial epicondyle of the humerus, with 15 cubic centimeters of 1 per cent procaine solution. We continue to record the temperatures of the histamine flare and of another area on the dorsum of the finger outside of the flare area every 5 minutes until the height of the temperature rise produced by the nerve block is reached. This occurs usually in 15 to 30 minutes and will be evidenced by cessation of the rise in temperature in the skin areas outside the histamine flare.

In the lower extremity these tests are carried out on the dorsum of the first toe. Complete anesthesia is produced in the toe by anesthetizing the posterior tibial nerve behind the medial malleolus and the common peroneal nerve below the knee as it winds around the neck of the fibula.

In analyzing the results in any case the normal averages must be kept in mind. In an individual with normal circulation, in a room at 20 to 22 degrees C., the temperature on the dorsum of the fifth finger varies between 27.8 degrees C. and 29.2 degrees C. and on the dorsum of the first toe between 27.2 degrees C. and 28.2 degrees C. The normal height of the temperature rise following nerve anesthetization varies between 33.0 and 34.2 degrees C. on the dorsum of the fifth finger and between 31.0 and 31.8 degrees C. on the dorsum of the first toe. The height of the temperature of the histamine flare varies between 32.8 and 34.6 degrees C. on the dorsum of the fifth finger and between 31.2 and 33.0 degrees C. on the dorsum of the first toe (7).

A flare temperature within the normal limits in a skin area the resting temperature of which is normal is indicative of a moderate or normal local arteriolar spasticity. If the resting skin temperature is below normal and the final temperature is equal to or above the normal marked arteriolar spasm is present. A temperature rise below the normal in the absence of arterial spasm indicates very slight arteriolar spasticity.

A rise in the skin temperature following nerve anesthetization which is within the normal limits in a skin the resting temperature of which is normal is indicative of moderate or normal arterial spasm. If the resting skin temperature is below normal and the final temperature is equal to the normal or greater, a marked arterial spasm is present. A temperature rise below the normal in the absence of local vasospasm indicates a very slight arterial spasm.

Various combinations of the two types of vasospasm can occur as is shown in Figure 1.

SUMMARY

1. Evidence is presented to show the presence of peripheral arterial and arteriolar spasticity.

2. Arterial spasticity is controlled by the autonomic nervous system and can be relieved by sympathetic ganglionectomy.

3. Arteriolar spasticity is controlled by a local nervous or chemical mechanism the exact nature of which is uncertain. It is affected only partially, if at all, by the autonomic nervous system, and it is not directly relieved by sympathetic ganglionectomy.

4. A method is suggested for differentiating between arterial and arteriolar spasticity in the selection of cases for sympathetic ganglionectomy.

I wish to thank Dr. L. N. Katz for his kind suggestions in the preparation of this report.

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HYDATIDIFORM MOLE AND CHORIOEPITHELIOMA

A 5 Year Study

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AN EFFORT has been made to analyze the records of all cases of hydatidiform mole and chorioepithelioma which have occurred on the Pacific Coast in the 5 years from 1931 to 1936. Since almost every member of this society has participated in the study, it is reasonable to assume that all cases recorded in the larger hospitals of the Pacific Coast have been studied. The purpose of this study is to appraise all the known facts concerning these cases, with special reference to early diagnosis, method of diagnosis, use of the Aschheim-Zondek test, classification of growths, treatment, and results. Additional purposes are to suggest a further study of chorioepithelioma and hydatidiform mole, going back into the records for another 10 years, to 1921, and to advocate the future study of these pathological entities in 5 year periods.

Of 127 cases of hydatidiform mole and 28 of chorioepithelioma studied in this group, only 2 of hydatidiform mole and 2 of chorioepithelioma have been previously reported.

HYDATIDIFORM MOLE

Parity. There are 127 cases of hydatidiform mole reported in this study. Of this number 44 occurred in primiparæ and 76 occurred in multiparæ. In 7 instances the parity was not stated. Over 80 per cent of the hydatidiform moles occurred in the first half of pregnancy. There was only one patient who had had a previous hydatidiform mole.

Symptoms. Bleeding was the outstanding symptom, and occurred in 122 patients. Vesicles were found in 18 patients, painful contractions were present in 28, and 27 had excessive nausea and vomiting.

Diagnosis. The diagnosis was made from curettings in 53 cases, from placental examination in 1, and after study of the specimen following hysterectomy in 6. A clinical diagnosis was made in 61 cases from passed mole or vesicles, in 2 from intermittent bleeding, and in 13 because the uterus was enlarged, with no palpable fetal parts, no audible fetal heart sounds, negative x-ray findings, and positive Aschheim-Zondek tests.

The uterus was reported as enlarged for the period of amenorrhea in 49 patients, normal in 36, and smaller than normal in 15; in 27 no information was given.

Occurrence with fetus. There were only 3 cases reported in which a fetus occurred with hydatidiform mole. In 1 case the hydatidiform mole was found during the routine pathological study of the placenta after the normal spontaneous delivery of a living infant of 6 pounds. In another case, which had been diagnosed as missed abortion, the pathological report showed an embryo 6 centimeters in length; the pathological diagnosis was early benign hydatid mole. In the third case, the mole passed 20 days after expulsion of a fetus.

Aschheim-Zondek test. In considering the use of the Aschheim-Zondek[1] test in this series, one is impressed with the fact that it was employed so infrequently. In 71 cases the test had either not been done at all or was not recorded. However, it was stated in some instances that the patient had been instructed to return for further tests but had not done so. The 56 remaining cases could be divided into two groups—in one, consisting of 28 cases, the test was done during the molar pregnancy; in the other, also consisting of 28 cases, the test was done only subsequent to treatment.

In the group in which the Aschheim-Zondek test was done during the molar pregnancy, the test became negative in 11 cases after curettage, in 8 after hysterectomy, in 2 after passage of the mole, in 1 after vaginal hysterotomy,

Read before the Pacific Coast Society of Obstetrics and Gynecology, Seattle, November 12, 1936.

[1]The Friedman modification of the Aschheim-Zondek test was used.

and in 1 after normal spontaneous delivery of a 6 pound infant (hydatid changes were found in the placenta). In 3 instances no Aschheim-Zondek test was done after hysterectomy. In 1 case the test was positive on 2 occasions after curettage; further tests were not obtained. In 1 case repeated Aschheim-Zondek tests remained positive for a 3 months' period after removal of a vaginal implantation, at which time the chorioepithelioma was discovered.

In the group in which Aschheim-Zondek tests were done only subsequent to treatment, the test showed negative results after curettage in 14 cases, after hysterectomy in 6, after passage of the mole in 2, and after vaginal hysterotomy in 1. In 2 instances the test remained positive after curettage; further Aschheim-Zondek tests were not done. In one case a supravaginal hysterectomy was done for persistently positive Aschheim-Zondek tests, but no hydatidiform mole or chorioepithelioma was demonstrable in the pathological specimen—no explanation was given for the positive reaction, and further tests apparently were not done. In another instance the test was negative the day before removal of the hydatidiform mole with sponge forceps, then positive 6 days later when a complete hysterectomy and bilateral salpingo-oophorectomy was performed. The pathological diagnosis after hysterectomy was syncytioma; therefore, the result of the first Aschheim-Zondek test must have been a false negative.

In 4 cases the urine was diluted to the point of obtaining a negative test: in 1 to 1.0 cubic centimeter; in 2 to 0.1 cubic centimeter; and in 1 to 0.01 cubic centimeter.

In only 1 case, which also had chorioepithelioma, was a quantitative estimation of prolan made. Seventy thousand mouse units of prolan per liter of urine were found.

In attempting to ascertain the time when the Aschheim-Zondek test became negative after operation, it was found that no definite conclusions could be drawn because there was such a great diversity in the number of tests done and in the number of intervening days. In some instances only one test was done long after operation. It was noted, however, that the majority of negative tests were reported in a period ranging from 10 to 50 days. Obviously, the only way to determine on what postoperative day the Aschheim-Zondek test becomes negative is to do a daily test. But in practically all the cases herein studied this was not done. In the very few instances in which is was done, it was observed that the test became negative on the fifth or sixth postoperative day. In every instance following the removal of hydatidiform mole or operation for chorioepithelioma, the Aschheim-Zondek test should be done daily until it becomes negative, then weekly for a month, and finally monthly for a few times. Only in this way can exact data be collected and can one be sure as to the presence or absence of the growth.

It might be well at this point to discuss the use of the Aschheim-Zondek test in relation to hydatidiform mole and chorioepithelioma. In the first place, one must remember that an incidence of laboratory error up to 2 per cent is to be expected. We should know that with the use of immature rabbits a false negative test is more probable than a false positive test. Therefore, a negative test which does not agree with the clinical picture might be false; and another test should be made, extreme care being used in collecting and labeling the urine specimen and in the technique of the test.

There appears to be a misconception that an increase of the ordinary amount of prolan in the urine of the pregnant woman indicates decisively that hydatidiform mole or chorioepithelioma is present. This is a fallacy and should not be perpetuated. I have seen cases in which there was a strongly positive Aschheim-Zondek reaction with only 1 drop of urine when there was a normal pregnancy, and I have seen a case of chorioepithelioma in which the test was negative with 1 cubic centimeter of urine. There are reports in the literature in which 50,000, 80,000, and even 200,000 units of prolan per liter have been found in the urine of a normally pregnant woman.

May I suggest that in cases in which the question of hydatidiform mole and chorioepithelioma is involved, we be absolutely meticulous in our use and technique of the Aschheim-Zondek test. Our greatest pitfall

is the false negative. I cannot believe that at any time in the transition of hydatidiform mole to chorioepithelioma there is any period in which the test is negative. I cannot believe that in the presence of chorioepithelioma it is possible to find an Aschheim-Zondek test fluctuating from negative to positive. For this reason, it would appear that if following hydatidiform mole one gets two or three negative tests (enough to avoid the possibility of a false negative) he can be sure no chorioepithelioma will develop from that molar pregnancy. I feel that we can rightfully conclude that as long as there is living chorionic tissue present the Aschheim-Zondek test will be positive, and if there is no living chorionic tissue present the Aschheim-Zondek test will be negative.

Operation. Dilatation and curettage was done on 94 patients, and hysterectomy on 29. Thirteen of the hysterectomies were supravaginal, 6 were total, and 10 were not designated as to type. Uterine packing and vaginal hysterotomy were each performed twice. The hydatidiform mole passed spontaneously 46 times.

Condition of the ovaries. The condition of the ovaries was apparently noted in only 28 cases; in 12 there was palpable enlargement, and in 14 there were lutein cysts. In the group with palpably enlarged ovaries, laparotomy was done on 9 patients; 5 of these had lutein cysts, and 2 had cysts which were not stated to be lutein. In those who died in this series, no enlargement of the ovaries and no lutein cysts were found.

Subsequent pregnancies. Subsequent pregnancies were reported in 16 patients, and in 1 of these, at the second pregnancy, there existed simultaneously an hydatidiform mole and a chorioepithelioma. In this series, chorioepithelioma followed hydatidiform mole in 12 patients (9.4 per cent).

Deaths. There were 3 deaths reported in the whole series of 127 hydatidiform moles, a percentage of 2.36. The detailed account of the deaths follows:

CASE 1. Mrs. M. W. had had 3 normal pregnancies and deliveries and gave no history of previous hydatidiform mole. She entered the hospital with severe toxemia in the second month of pregnancy. She had hypertension with visual disturbance, epigastric pain, and albuminuria. No vesicles were seen. There was no bleeding or other evidence which might have aided in the diagnosis. Because of the severe fulminating toxemia, a therapeutic abortion was done at 2½ months and a hydatidiform mole was removed, following which the patient died in 24 hours. There were no Aschheim-Zondek tests made and no autopsy recorded. All other information was lacking.

CASE 2. Mrs. E. S., aged 46 years, had had 3 full term spontaneous deliveries with no previous history of hydatidiform mole. There was considerable bleeding when the patient was first seen, but the diagnosis was not made until the mole was passed in the third month. Twenty-two days later a hysterectomy was performed. The type of hysterectomy was not stated, and no reason was given for it. The patient died of streptococcic peritonitis 5 days after the hysterectomy. There were no Aschheim-Zondek tests done and no autopsy reported. It was stated that the ovaries were not enlarged on palpation, that lutein cysts were not seen at operation, and that chorioepithelioma was not found in the specimen.

CASE 3. Mrs. E. F., aged 48 years, with 3 living babies and 8 miscarriages, had intermittent bleeding from the uterus. When seen, she was supposed to have been in the sixth month of pregnancy. A tumor was found extending to the umbilicus. No fetal movement was apparent and no fetal heart sounds were heard. Before operation a diagnosis of placenta prævia was made. A low amputation of the uterus was done. The uterus after removal was found to be filled with a hydatidiform mole. The patient died on the operating table.

In Findley's collection of 500 cases, reported from the literature in 1910, chorioepithelioma occurred in 157 cases, or 31.4 per cent of the reported hydatidiform moles. In our series this incidence was only 9.4 per cent. The difference is explainable by the fact that Findley's cases were almost all reported from the literature while ours were collected from records after being sought for. It is obvious that the incidence of chorioepithelioma would be much higher in a group of reported cases than in a group of unreported cases.

In Findley's series, 11 of 87 patients with benign hydatidiform moles died (12 per cent), and 46 of 99 patients with malignant moles died (46 per cent). In our series nearly every patient was operated upon, while in Findley's series 43.2 per cent of the patients delivered the hydatidiform mole spontaneously. This fact, plus the type of operation done, certainly accounts for a great deal of the differ-

ence in the mortality—modern conduct, better diagnosis, and earlier treatment were important factors in the lowered mortality; such *passé* methods as the use of the bougie, hydrostatic bag, and digital removal were not practiced. In our series the use of the Aschheim-Zondek test certainly saved some lives.

It would appear that immediate hysterectomy, once the diagnosis is established, would be the surest method of prophylaxis against chorioepithelioma, but this is rather formidable treatment. As can be seen by our study of this series, the operation would have been done needlessly 115 times, for only 12 patients developed chorioepithelioma after hydatidiform mole. What is more, hysterectomy would have prevented no deaths in our series, since 1 patient died of fulminating toxemia before the diagnosis was made, and 2 deaths actually followed hysterectomy. In studying this series, one wonders if hysterectomy would have saved any of the patients who died subsequently of chorioepithelioma. In the detailed account of the 2 deaths which occurred from chorioepithelioma, we find that in the first case hysterectomy was done as an emergency when the first symptoms appeared and when there was no evidence of hydatidiform mole, and that this death took place on the operating table. In the second death from chorioepithelioma, the malignant growth actually occurred with the pregnancy and there was no history whatever of hydatidiform mole. We can draw the conclusion, from our study of the present series, that hysterectomy *per se* as treatment for hydatidiform mole would not have saved any lives.

I believe that hysterectomy should be done as soon as the diagnosis is made only on patients near the menopause or when the mother already possesses sufficient children, and I disagree with Caturani who states that all forms of chorionic tumors should be treated according to the general criteria adopted for malignant tumors. I do believe, however, that all forms of chorionic tumors should be watched and studied as potentially malignant tumors. In other patients, one should do a careful but thorough curettage, followed by packing in case of hemorrhage, to clean the uterus and to aid in arriving at a diagnosis. And because a curettage does not of necessity remove chorionic tissue buried in the myometrium or a sinus, frequent Aschheim-Zondek tests should be done for the purpose of establishing the fact as to whether or not there is living chorionic tissue still remaining. Hysterectomy should be resorted to if there is a persistently positive Aschheim-Zondek test, and if one is sure that the uterus has been properly emptied and that no intervening pregnancy has taken place. This method appears at this time to offer the maximum percentage of prevention and cure and the minimum amount of unnecessary operations.

Further, by way of prophylaxis against serious complications and chorioepithelioma, the alert practitioner should be suspicious of the pregnant woman who has a uterus enlarged out of proportion to the age of her pregnancy, who has excessive nausea and vomiting, who bleeds and has painful uterine contractions, and who aborts. In such patients he should watch for vesicles, have the abortion tissue examined, and use the Aschheim-Zondek test after doubtful or suspicious abortions. And, too, the woman who bleeds from unknown cause after abortion or delivery should be watched with the idea of chorioepithelioma in mind, and the Aschheim-Zondek test should be used as a check.

CHORIOEPITHELIOMA

Parity. In this study 28 cases of chorioepithelioma are reported. Nineteen occurred in multiparæ and 9 in primiparæ. Fifteen chorioepitheliomas of this series followed moles, 7 followed pregnancies or abortions, 5 existed simultaneously with mole, and 1 occurred coincidentally with pregnancy.

Symptoms. As was the case with the moles, bleeding, nausea and vomiting, and painful uterine contractions were the outstanding symptoms. Twenty-five patients bled, 3 had nausea and vomiting, 5 had pain, and 1 had absolutely no symptoms.

Diagnosis. The diagnosis was made clinically and with the aid of the Aschheim-Zondek test in 9 cases, from curettings in 15, after hysterectomy in 4.

Aschheim-Zondek test. In the chorioepithelioma series, the Aschheim-Zondek test

was used in 50 per cent of the 28 cases. In 12 the test was done both before and after hysterectomy, and in each instance it became negative after the operation; but in 1 it became positive again, then negative, and finally positive. This patient died. In 2 cases the test was done only after hysterectomy, and in both was reported negative.

Prolan was estimated in 2 cases. In 1 (where chorioepithelioma occurred simultaneously with hydatidiform mole), 70,000 mouse units of prolan per liter of urine were found, and after hysterectomy the Aschheim-Zondek test was negative. In the other, 4,000 rat units of prolan per liter of urine were found 4 days after curettage. Another prolan estimation in this case 5 days after panhysterectomy and salpingo-oophorectomy, performed approximately 5 weeks after the curettage, showed 50,000 rat units of prolan per liter of urine; subsequent Aschheim-Zondek tests were negative.

Operation. In treating these patients, 24 hysterectomies were done, 14 total and 10 supravaginal. Three patients were treated by dilatation and curettage. One had a vaginal implantation removed.

Condition of the ovaries. Of the 28 cases of chorioepithelioma, lutein cysts were reported in 7, in 9 there were no cysts, and in 12 the condition of the ovaries was not reported. Both ovaries were removed in 12 patients, 7 of whom were under 30 years of age.

Classification. The pathological report as to type in the chorioepithelioma series was as follows: syncytioma in 8 cases, chorio-adenoma in 5, choriocarcinoma in 3, and not stated in 12. Lutein cysts were found in 4 of the cases of syncytioma, in 2 of chorio-adenoma, in 1 of choriocarcinoma, and in 1 in which no classification had been made. Metastasis at operation was reported in 5 cases, and lung metastasis occurred in 1.

X-ray and radium. X-ray was used on 5 patients, and on 1 together with radium. In each instance this treatment followed operation. The patient who had the combined radium and x-ray treatment died.

Deaths. While Findley's study of 99 cases of chorioepithelioma showed 46 deaths (46 per cent) our study of 28 cases showed only 2 deaths (7.1 per cent). A detailed account of the deaths follows:

CASE 1. Mrs. E. F., aged 48 years, tripara (all living), who had a history of a number of abortions, missed her menstrual periods for 3 months, then began to flow at frequent intervals. An emergency supravaginal hysterectomy was done because of the profuse hemorrhage. The patient died on the operating table. The type of chorioepithelioma was not stated. No history of previous mole was mentioned, and there was no autopsy. No other information was given.

CASE 2. Mrs. I. S., aged 29 years, quadripara, entered the hospital with severe vaginal bleeding. Blood pressure was 70/26. She gave no history of hydatidiform mole, but stated that she had not menstruated for 36 days. Curettage was performed, and the presence of both types of chorionic villi epithelium complicated the final pathological decision even though the syncytial cells predominated. The next day the Aschheim-Zondek test was positive. On the following day a panhysterectomy and bilateral salpingo-oophorectomy was done and a roundish, purplish-gray growth, 1.5 centimeters in diameter, was found near the fundus, projecting into the endometrial cavity. No metastases were found at the time of this operation, and no lutein cysts were seen in the ovaries. The pathological report was as follows: "Both ovaries normal. Chorioepithelioma of the uterus, of the choriocarcinoma type." Ten days later examination revealed the presence of a typical dark purplish nodule, .05 centimeter in diameter, on the anterior vaginal wall. The Aschheim-Zondek tests were all positive, several having been made. One test with 5 cubic centimeters of the spinal fluid was positive. The urine was not positive in high dilutions, but was constantly positive with 1 cubic centimeter of urine. Both x-ray and radium were used on the growth in the anterior vaginal wall. The patient died 110 days after the first symptoms. There were no metastases of the lungs visible by x-ray.

Every case of chorioepithelioma in which an Aschheim-Zondek test was reported gave a positive test. Every case of hydatidiform mole in which an Aschheim-Zondek test was reported gave a positive test. It is impossible to conceive of a negative Aschheim-Zondek test in the presence of chorioepithelioma. However, one can conceive of a negative Aschheim-Zondek test in a case of hydatidiform mole. It is logical to assume that the case in which the Aschheim-Zondek test was negative the day before the hydatidiform mole was removed by sponge forceps comes in a class analogous to missed abortion and could be called missed molar abortion. In such a case, the hydatidi-

form mole would be entirely separated from its uterine attachment—still lying in the uterus, but absolutely separated from all circulation. This compares in a manner to missed abortion where the placenta and fetus are still lying in the uterus absolutely unattached and where there would be a negative Aschheim-Zondek test.

I have endeavored to correlate our findings regarding enlarged ovaries or lutein cysts in relation to hydatidiform mole and chorioepithelioma, but at this time I am unable to make any progress in this correlation. I have attempted to correlate the occurrence of lutein cysts with the stage of development of the growth, and to correlate the occurrence of lutein cysts with the pathological type of the growth, with metastasis, or with fatality, but I can see no correlation whatever. However, in the 7 cases in the chorioepithelioma series in which lutein cysts were reported as being present, with the exception of the one patient seen late and who died of lung metastases, the diagnoses were made comparatively early. I hope that in future cases special attention will be paid to the ovaries examined on palpation and those seen at laparotomy.

In the past decade, many previously unknown facts have been brought to bear on the study of hydatidiform mole and chorioepithelioma. The use of the Aschheim-Zondek test in both diseases, the proper pathological classification of chorioepithelioma, and the type of operation best suited to cure the condition, are all comparatively recent advances. In hydatidiform mole, after passage or removal of the mole, the judicious use of the Aschheim-Zondek test has enabled us to determine whether or not any portion of the mole remains or whether there has been a transition to chorioepithelioma.

Practically 80 per cent of the chorioepitheliomas were found within 20 days after the passage of the mole in those cases in which the patient had been properly examined, in which sufficient Aschheim-Zondek tests had been done, and in which pathological specimens were examined. This fact, plus my own clinical experience, has led me to the hypothesis that certain cases of mole have the potentiality of malignancy. In these patients the malignancy is present with the mole—the actual malignant chorionic changes have already taken place, and even though the mole be removed, the malignant cells are left. At this time the Aschheim-Zondek test will be positive and will remain positive until the chorionic tissue is dead or has been removed. By the use of the pathological examination and classification of the growth, and by the results of the Aschheim-Zondek tests in cases of chorioepithelioma, we can treat patients in most cases early enough to avoid metastases and to save the woman and her ovaries.

NOTE.—The author is indebted to practically every member of the Pacific Coast Society of Obstetrics and Gynecology for the case histories.

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FALLACIES CONCERNING CHEMICALLY STERILIZED SURGICAL CATGUT SUTURES

With Particular Reference to the Use of Metallic Silver

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THE problem of sterilizing surgical catgut sutures by some chemical method has received intensive study for many years by investigators in several countries. In fact, the chemical compounds which have been used in an attempt to destroy bacteria commonly present in raw catgut are almost legion. During the course of his investigations, Mackie tried out many compounds, including silver nitrate, but found them lacking in true bactericidal properties so far as catgut was concerned. Bulloch reviewed the disinfecting power of numerous chemicals, among which were silver compounds, and found them inefficient as sterilizing agents for commercial catgut.

Silver catgut. And now there has appeared on the market silver catgut which is a new representative of the chemical method of sterilizing catgut sutures. As reported by Lieb, the method of saturating surgical dressings and sutures with metallic silver was devised by Kopetschni; and the final product is supposed to possess "optimal oligodynamic action." Lieb states:

> Very probably the silver surface fixed to the surgical dressing gives off silver ions, yet in such small quantities that the concentration of the dissolved ions can not yet have any injurious irritant effect, although it is quite sufficient to develop any bactericidal properties.

Lieb used what he termed "a special test" for studying the bactericidal action of the silver saturation process on artificially infected catgut. He smeared a culture containing spores of Bacillus anthracis on two pieces of water-soaked catgut about 2 centimeters long. One was placed on an agar plate; the other was saturated with silver and then placed on an agar plate. Both plates were incubated at 37 degrees C. for 48 hours. The non-saturated catgut presented a zone of bacteria, while the saturated catgut showed none. Thereupon, the saturated catgut was tested for sterility in bouillon for 96 hours, but no growth was demonstrable. He claims that this test proved that the silver-saturated catgut has a bactericidal action on anthrax spores.

Linhart subjected to clinical trial the silver-impregnated suture material of Lieb and Kopetschni. He states:

> In the aseptic treatment of wounds, this suture material is especially valuable because of the absolutely reliable sterility of the catgut. . . . The material is not only sterile, but has at the same time a highly antiseptic effect.

Furthermore, he claims:

> This type of silver impregnation is able to destroy or render harmless all the germs and their spores located in the raw catgut, and in addition any stray germs of the silver catgut. Moreover, the silver has an absolutely non-irritant and even a heterogeneous action on the living tissue.

The idea of saturating catgut with silver as a chemical sterilizing agent closely parallels that of attempting to sterilize catgut sutures with some of the other heavy metals, notably copper and mercury. Therefore, a concise presentation here of the results of my earlier research studies, in which the sterility of copperized and mercurialized catgut sutures was investigated, may serve to clarify the study of chemical sterilization as it is applied to silver catgut which forms the basis of the present paper.

In a previous paper (4), I described the results of my research on the possibility of effectively sterilizing catgut by means of chemical treatment. The sterilizing action of 27 different chemical compounds, including various salts of two of the heavy metals (copper and mercury), was found to be inefficient and unreliable when applied to several thousand catgut sutures. Accordingly, I endeavored to

emphasize the fact that "*the net results indicate the fallacy of the chemical method of sterilizing catgut.*"

Copperized catgut. This was first prepared by von Linden at the University of Bonn in Germany. It was claimed that by saturating catgut with copper salts, such treatment would completely sterilize the sutures, destroying even tetanus spores; and that such sutures would remain sterile for weeks, even when left exposed to air and dust.

In my paper on chemical sterilization (4), I pointed out the fact that copper salts had been demonstrated to exert a bacteriostatic action on bacteria, thereby depriving them of nutritional support and preventing their multiplication; but that the bacteria may be reactivated by means of a neutralizing solution capable of redissolving the copper salts. My bacteriological tests, in which I used an effective neutralizing fluid for removing all the copper from the catgut as a preliminary step, when applied to 36 copperized catgut sutures of a German manufacturer and 156 copperized catgut sutures of three American manufacturers, showed that 19 of the German and 42 of the American sutures contained living bacteria. When copperized catgut sutures were embedded in the tissues of laboratory animals, the results showed that these sutures were less readily absorbed and were definitely *more irritating* than plain catgut untreated with copper.

Mercurialized catgut. In 1932 chemical analyses of catgut sutures of an American manufacturer showed them to be heavily impregnated with a mercury compound; and, when such sutures were tested bacteriologically by the Meleney and Chatfield method, entire absence of bacterial growth was indicated. Further investigation revealed that the neutralizing fluid (1 per cent sodium thiosulphate and 1 per cent sodium carbonate) recommended by these authors would not remove all the mercury compound from the sutures. Subsequently, the sutures of a British manufacturer were likewise found to contain such a large amount of the soluble mercury compound that the neutralizing solution (1 per cent sodium thiosulphate and 1 per cent sodium carbonate), specified in the Therapeutic Substances (Catgut) Regulations of 1930, would not remove all the mercury compound from the catgut.

Further research studies demonstrated that all the mercury compound could be removed by means of a special neutralizing solution of 10 per cent sodium thiosulphate. When this solution was used as an additional preliminary step in the bacteriological technique, subsequent lots of sutures from the American and from the British manufacturer showed an abundance of bacterial growths in the aerobic and in the anaerobic tubes. This special neutralizing solution is now embodied as part of my technique (5), in which it is described as Formula B. Thus, just as my research work proved copperized catgut to be a fallacy so far as sterility is concerned, so also has it demonstrated with equal forcefulness the fallacy of attempting to sterilize catgut sutures with mercury compounds.

SILVER CATGUT SUTURES

The broad claims advanced by Linhart concerning the absolute sterility of silver catgut seemed to indicate that an effective method of chemical sterilization of surgical catgut had been developed. Naturally, this evoked my interest and for two reasons: first, because Mackie as well as Bulloch had investigated the value of silver compounds as sterilizing agents for catgut and found them inefficient; and second, the intensive study (4) which I had made during a period of 2½ years of the possibility of effectively sterilizing catgut by means of chemical treatment, involving 27 different compounds, proved conclusively the fallacy of chemical sterilization of surgical catgut. Therefore, it seemed desirable to subject silver catgut to a comprehensive series of tests with the object of corroborating, if possible, the findings on which Linhart based his claims. I decided to undertake such an investigation and, in the latter part of 1935, I purchased in the open market a quantity of silver catgut consisting of several sizes of sutures (Nos. 0, 1, 2, 3, and 4).

EXPERIMENTS AND RESULTS

Bacteriological tests. Several sutures of the silver catgut, comprising sizes 0, 1, 2, 3, and 4, were tested for sterility in accordance with the

TABLE I.—SILVER CATGUT SUTURES*

Series No.	Size	Aerobic tests				Anaerobic tests			
		Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Tube 6	Tube 7	Tube 8
831	0	o	o	o	o	o	o	o	o
832	1	o	o	o	o	o	o	o	o
833	2	o	o	o	o	o	o	o	o
834	3	o	o	o	o	o	o	o	o
835	4	o	o	o	o	o	o	o	o
836	0	o	o	o	o	o	o	o	o
837	0	o	o	o	o	o	o	o	o
838	1	o	o	o	o	o	o	o	o
839	1	o	o	o	o	o	o	o	o
840	2	o	o	o	o	o	o	o	o
841	2	o	o	o	o	o	o	o	o
842	2	o	o	o	o	o	o	o	o

*Tested by method of Bacteriological-Serological Research Institute in the Ministry for Social Administration (Public Health Office), Vienna.
Explanation. o means entire absence of growth in the tube at end of 15 days' incubation.
Chemical analyses showed that this catgut contained over 2½ per cent metallic silver; also that all the silver was not removed from the sutures by the 2-hour immersion in 5 per cent sodium thiosulphate used as a neutralizing solution in this technique.

technique used by the Bacteriological-Serological Research Institute in the Federal Ministry for Social Administration (Public Health Office), Vienna, as described in reports submitted by the manufacturer. Under aseptic technique, the sutures were placed in test tubes containing a sterile solution of 5 per cent sodium thiosulphate for 2 hours; and then they were immediately transferred to test tubes containing a sterile culture medium previously described (5). One-half the quantity of each of the different sizes of sutures was cultured aerobically and the other half anaerobically. At the end of the 15 day incubation period, there was entire absence of bacterial growth in all tubes (Table I). These results seemed to corroborate the claims of Linhart and those of the manufacturer that silver catgut sutures are sterile.

Chemical analyses. Next, the various sizes of silver catgut were subjected to chemical analyses which revealed a large amount (over 2.5 per cent) of metallic silver in the sutures. Investigations were then conducted for the purpose of devising a suitable neutralizing fluid effectively to remove all the silver from the sutures. It was found that a solution of 5 per cent sodium thiosulphate would not remove all the silver when the catgut was left in this neutralizing fluid for 2 hours, nor even when incubated in the solution for 24 hours. Further research demonstrated that this could be attained by means of a neutralizing fluid consisting of *10 per cent sodium thiosulphate* in which the catgut must be incubated for not less than 48 hours. This is the special neutralizing fluid described as Formula B in my bacteriological method (5) and which I had found to be so efficient, as an additional preliminary step to my regular technique, for removing large amounts of mercury and iodine from catgut.

Special bacteriological technique. Therefore, as the next logical procedure in this research study, several sutures of silver catgut comprising sizes 0, 1, 2, 3, and 4 (taken from the same lots as those sutures which showed entire absence of growth when tested by the technique above described), were tested bacteriologically by first transferring them aseptically to, and incubating them in, a sterile neutralizing solution of 10 per cent sodium thiosulphate for 48 hours; and then by putting them through my regular bacteriological technique (5). *The results of these tests showed an abundance of growths in the aerobic as well as in the anaerobic tubes; thus demonstrating the presence of living bacteria in the sutures* (Table II).

Reaction of tissues to silver catgut. While my bacteriological tests on silver catgut were in

progress, 20 day chromic catgut sutures (sizes 0, 1, and 2) of a standard brand which were sterilized by heat, and similar sizes of the silver catgut sutures, were embedded in living animal tissues for the purpose of determining the relative degree of tissue irritation, if any, and the comparative rate of absorption of the two varieties of catgut.

Each of these two kinds of sutures was embedded in the submucosal layer of the cat's stomach. The animals were sacrificed at intervals of 3, 5, 8, 12, 20, and 30 days. After noting the gross pathological appearance of the removed stomachs, illustrative pieces of tissue containing the sutures were placed in 10 per cent formaldehyde and histological sections made and mounted on microscopic slides. Simple hematoxylin eosin stain as well as the fibrous tissue differential stain of van Gieson was used.

A study of the histological appearance of the tissues after the sutures had been embedded for 3 days showed almost complete absorption of sizes 0 and 1 of the silver catgut sutures, together with a *very marked leucocytic reaction with infiltration of cells of abscess-like appearance.* The size 2 silver catgut sutures showed partial absorption together with a very marked polymorphonuclear leucocytic reaction. The histological appearance of these silver catgut sutures showed that their tensile strength at this time must have been negligible. The 20 day chromic catgut sutures used as a control showed entire absence of absorption and almost no tissue reaction.

Examination of the tissues after the sutures had been embedded for 5 days showed that *all sizes of the silver catgut sutures had been completely absorbed* except for a few fragments, and there was a *very extensive leucocytic reaction* extending through the surrounding tissue. On the other hand, the 20 day chromic catgut sutures were well preserved and accompanied by relatively little tissue reaction.

The silver catgut sutures that were embedded in the tissues for 8 days were completely absorbed and there was a moderate cellular reaction at their former site in the submucosa; while the 20 day chromic catgut sutures were well preserved with slight tissue reaction surrounding them.

Examination of sections of tissues in which the two series of sutures had been embedded for 12, 20, and 30 days revealed no evidence of the silver catgut sutures. On the other hand, the control sutures of 20 day chromic catgut which had been embedded for periods of 12 and 20 days were well preserved and showed moderate fibroblastic reaction; while the control sutures that were embedded for 30 days could still be identified by a few remaining fragments in the submucosa, and adjoining this zone was a small circumscribed region of fibroblasts.

DISCUSSION OF RESULTS

1. Bacteria. The results of my bacteriological tests of silver catgut sutures, wherein living spore-forming bacteria were found, appear to refute completely Linhart's statement that the process of silver impregnation used in the preparation of silver catgut "is able to destroy or render harmless all the germs and their spores located in the raw catgut." The presence of these living, spore-bearing microorganisms, which I demonstrated in the silver catgut sutures, also disproves the claim that silver catgut sutures are absolutely sterile when manufactured.

2. Neutralizing fluids. The results of my researches on silver catgut have again emphasized the fact that falsely negative findings may follow bacteriological tests applied to sutures unless a close check-up is always made: first, by subjecting some of the sutures to careful chemical analyses to determine the nature and quantity of the chemical compound that may be present; second, by using, in connection with the bacteriological tests, a suitable neutralizing fluid which will dissolve and *completely remove* the chemical compound found to be present.

My experiments have also proved the fallacy of using 5 per cent sodium thiosulphate for 2 hours as a neutralizing solution, and then immediately transferring the silver catgut to nutrient culture medium. This is the technique used by the Bacteriological-Serological Research Institute in the Federal Ministry for Social Administration (Public Health Office), Vienna. There are two good reasons why this technique fails to detect the living bacteria in

TABLE II.—SILVER CATGUT SUTURES*

Series No.	Size	Aerobic tests						Anaerobic tests					
		Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Tube 6	Tube 7	Tube 8	Tube 9	Tube 10	Tube 11	Tube 12
831	0	G 48 hrs.	0	0	0	0	0	0	0	0	0	0	0
832	1	G 48 hrs.	0	0	0	0	0	0 6 days	0	0	0	0	0
833	2	G 48 hrs.	G 48 hrs.	0	0	0	0	0	0	0	0	0	0
834	3	G 48 hrs.	G 6 days	0	0	0	0	0	0	0	0	0	0
835	4	G 12 days	G 12 days	0	0	0	0	0	0	0	0	0	0
836	0	0	0	0	0	0	0	0	0	0	0	0	0
837	0	0	0	0	0	0	0	0	0	0	0	0	0
838	1	0	0	0	0	0	0	0	0	0	0	0	0
839	1	G 48 hrs.	G 10 days	0	0	0	0	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 3 days	0	0
840	2	0	0	0	0	0	0	0	0	0	0	0	0
841	2	G 48 hrs.	G 48 hrs.	G 48 hrs.	0	0	0	G 48 hrs.	G 48 hrs.	0	0	0	0
842	2	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 10 days	G 10 days	0	G 48 hrs.	G 4 days	0	0	0	0

*Tested by standard Clock method, but a special neutralizing solution of 10 per cent sodium thiosulphate was used as a preliminary additional step
Explanatory. G indicates bacterial growth, followed by the number of hours' or days' incubation that elapsed before growth appeared. 0 means entire absence of growth in the tube at end of 15 days' incubation.
These sutures were taken from the same lots and bore the same batch numbers as the sutures used for the tests shown in Table I.
Before being put through the standard Clock technique, these sutures were transferred aseptically to tubes of sterile 10 per cent sodium thiosulphate and incubated for 48 hours to remove the large amount of silver (over 2.5 per cent).

the silver catgut. First, the large amount of silver in the catgut cannot be removed in 2 hours nor in 24 hours by this neutralizing fluid. As is pointed out below, silver has a bacteriostatic action; and the large amount of the metal remaining in the sutures after they have been in contact with 5 per cent sodium thiosulphate for 2 hours prevents bacterial growth. Second, no provision is made in this technique for removing from the sutures the soluble double salt of silver and sodium thiosulphate $(NaO_3S_3Ag)2\text{-}Na_2S_2O_3$, and with which the sutures are saturated as a result of their immersion in the neutralizing solution, before placing the sutures in the culture medium; and, hence, this double salt is carried over into the culture medium where it tends to inhibit bacterial growth. Therefore, this technique permits two chemical compounds to act as inhibiting agents of bacterial growth: first, that portion of the metallic silver which is not dissolved out by the neutralizing fluid; and, second, the soluble double salt present in the sutures after their stay in the neutralizing solution and which is carried over by the sutures into the culture medium.

It is to be noted here that Buehrman recommended rinsing after the silver had been neutralized with sodium thiosulphate; and in the improved technique which I devised (4) and recommended (5) for testing the sterility of catgut sutures which are heavily impregnated with metals, the sutures are transferred to distilled water after the preliminary treatment in the special neutralizing fluid.

3. Bacteriostatic action of silver. From a study of the results of my researches on silver catgut described in this paper, it is evident that when catgut sutures are treated with metallic silver, an arrested development of the bacteria within the catgut is brought about through the bacteriostatic action of silver. It seems apparent that the silver acts on the bacterial colloid in such a manner that even in the presence of a suitable culture medium the bacteria are deprived of their nutritional support. This action is analogous to that of copper and mercury (4). It is equally evident

from my experiments that the removal of all the silver from the catgut by means of an effective neutralizing fluid of 10 per cent sodium thiosulphate for not less than 48 hours reactivates the bacteria; so that when nutritional support is provided in the form of a proper culture medium bacterial growth occurs. My experiments herein described have demonstrated conclusively that *metallic silver does not effectively sterilize catgut.*

Kruse and Fischer claimed to have activated metallic silver by direct action of an electric current, producing silver chloride with reputed oligodynamic action. However, they frankly admit that by their silver treatment "bacterial spores are not killed; but they do not germinate." Experiments conducted by Bauer showed that spores of Bacillus subtilis and Bacillus anthracis were not killed by Kruse and Fischer's colloidal silver chloride.

Buehrman demonstrated that the bacteriostatic action of metallic silver can be neutralized by immersion in a solution of sodium thiosulphate *followed by rinsing.* He states:

> The silver salt in combination with the thiosulphate forms the silver-sodium thiosulphate with the formula NaO_3S-SAg, which is transformed into the readily soluble double salt $(NaO_3S_3Ag)2$-$Na_2S_2O_3$. It very easily dissolves in subsequent rinsing.

In Lieb's experiments which were briefly described in the early part of this paper, there naturally was an absence of bacteria on the plate containing the piece of silver saturated catgut; likewise, when this piece of catgut was incubated in bouillon for 96 hours there would be no demonstrable growth. This investigator failed to take into account the fact that silver brings about an arrested development of the bacteria within the catgut through the bacteriostatic action of the metal.

4. Tissue reaction. The marked leucocytic reaction of abscess-like appearance which was observed in the animal experiments which I have described completely refutes the statement of Linhart that "the silver has an absolutely non-irritant action on living tissues," as well as that of Lieb that "the concentration of dissolved (silver) ions cannot have any injurious irritant effect."

The results herein described of embedding silver catgut in living animal tissues are supported by the work of Jensen and Jensen. In a series of experiments in which they studied the antiseptic action of certain metals, these investigators found that silver oxide possesses a strongly irritant action on the tissues of laboratory animals and human subjects. They also demonstrated that silver chloride combines with, and irritates, the tissues of the experimental animals.

It is claimed that absorption of the silver will take place within the latest 20 to 28 days and after this period the catgut will be absorbed normally like any other catgut. It was this statement that influenced me to select 20 day chromic catgut as control sutures for the animal tissue experiments. Instead of persisting in the tissues for 20 to 28 days as claimed, all sizes of the silver catgut were *completely absorbed after 5 days!* In other words, the large amount of metallic silver in the catgut caused early and severe tissue irritation, with resultant inflammatory reaction and infiltration of cells. Then, the excessive cellular activity of the infiltrated leucocytes hastened the digestion and absorption of the catgut.

SUMMARY

Silver catgut, comprising several sizes of sutures, was tested for sterility by the same technique as that employed by the Bacteriological-Serological Research Institute in the Federal Ministry for Social Administration (Public Health Office), Vienna, wherein sutures are placed for 2 hours in a neutralizing solution of 5 per cent sodium thiosulphate and immediately transferred to nutrient culture medium. Entire absence of bacterial growth after 15 days' incubation apparently indicated sterility of the sutures.

Chemical analyses of the sutures revealed the presence of a large quantity (over 2.5 per cent) of metallic silver.

Experiments showed that this large amount of silver could not be removed from the sutures in 2 hours nor in 24 hours by means of a solution of 5 per cent sodium thiosulphate; but that all the silver could be effectively removed by means of a neutralizing solution of 10 per cent sodium thiosulphate, in which the catgut must be incubated for at least 48 hours.

When this special neutralizing solution of 10 per cent sodium thiosulphate was used as a preliminary additional step to my regular bacteriological technique (5), all sizes of the silver catgut were found to be non-sterile.

The micro-organisms thus found proved to be spore-bearing bacteria.

Three sizes of silver catgut sutures, together with similar sizes of 20 day chromic catgut of a standard brand which was sterilized by heat, were embedded in living animal tissues. The animals were sacrificed at intervals of 3, 5, 8, 12, 20, and 30 days, and a comparative study made of the histological appearance of the tissues. After 3 days, there was almost complete absorption of the smaller sizes of the silver catgut sutures, together with a *very marked leucocytic reaction with infiltration of cells of abscess-like appearance;* while the 20 day chromic control sutures showed entire absence of absorption and almost no tissue reaction. After 5 days, all sizes of the silver catgut sutures were *completely absorbed* and there was very extensive leucocytic reaction; while the 20 day chromic sutures were well preserved and accompanied by little tissue reaction. After 8, 12, 20, and 30 days there was no evidence of the silver catgut sutures; but the 20 day chromic control sutures showed moderate fibroblastic reaction and were well preserved after having been embedded for 20 days, and could still be identified by a few fragments after 30 days.

CONCLUSIONS

1. The presence of living spore-bearing bacteria in the silver catgut sutures seems to refute the claims of Linhart that the silver impregnation process destroys "all germs and their spores located in the raw catgut"; and certainly disproves the manufacturer's claim that the sutures are "absolutely sterile when manufactured."

2. The technique used by the Bacteriological-Serological Research Institute in the Federal Ministry for Social Administration (Public Health Office), Vienna, for testing the sterility of silver catgut, wherein sutures are placed for 2 hours in a neutralizing solution of 5 per cent sodium thiosulphate and immediately transferred to nutrient culture medium, is unreliable and yields falsely negative findings.

3. The fallacy of using such bacteriological technique is twofold: first, my experiments proved that 5 per cent sodium thiosulphate is ineffective as a neutralizing fluid for removing the large amount of silver from the sutures in 2 hours or even 24 hours; and second, transferring the sutures immediately from this neutralizing solution to the culture medium carries the double salt of silver and sodium thiosulphate over into the culture medium where it tends to inhibit bacterial growth.

4. My research studies of the sterility of silver catgut proved not only that *metallic silver does not effectively sterilize catgut,* but also that the metal exerts a bacteriostatic action whereby the development of the bacteria within the catgut is arrested. The silver apparently acts on the bacterial colloid in a manner similar to that of copper and mercury (4). Removal of all the silver from the catgut by means of an effective neutralizing fluid of 10 per cent sodium thiosulphate for 48 hours reactivates the bacteria which are thus enabled to grow when provided with nutritional support in the form of suitable culture medium.

5. The reliability and efficiency of my bacteriological method (5) for testing the sterility of surgical catgut sutures were demonstrated again in this research study of the sterility of silver catgut.

6. The results herein described of embedding silver catgut in living animal tissues proved conclusively that such sutures were definitely *irritating to the tissues,* as evidenced by the very marked leucocytic reaction with infiltration of cells of abscess-like appearance which they induced. This condition disproves the statements of Linhart and also of Lieb to the effect that "the silver has an absolutely non-irritant action on living tissues," and "the concentration of dissolved (silver) ions cannot have any injurious irritant effect."

7. The animal experiments herein described showed also that all sizes of silver catgut were *completely absorbed after 5 days;* thus refuting the claims of the manufacturer that "absorption of the silver will take place within the latest 20 to 28 days and after this period our catgut will be absorbed normally

like any other catgut." These results indicate that the large amount of metallic silver in the catgut caused early and severe tissue irritation, with resultant inflammatory reaction and infiltration of cells; and the excessive cellular activity of the infiltrated leucocytes hastened the digestion and absorption of the catgut.

8. Although the purpose of using chemical ("cold process") sterilization for catgut sutures is evidently twofold: permitting the use of inferior raw catgut which may yield sutures of fairly good physical properties that would be destroyed by heat sterilization, and eliminating the expensive heat sterilization process; nevertheless, since it is possible so easily to procure heat sterilized catgut sutures that possess all surgical requisites, I can see no place for chemically sterilized sutures with their resultant uncertain sterility.

9. A careful study of the results of my bacteriological examinations of silver catgut sutures serves to emphasize the importance of two conclusions set forth in a previous paper (4): "(1) *The so called chemical sterilization of surgical catgut by any method yet devised is inefficient and unreliable.* (2) *Carefully controlled heat sterilization is the only uniformly reliable and positive method of sterilizing surgical catgut sutures.*" Hence, the desirability of using an approved, well known brand of heat sterilized sutures should be quite evident.

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AN EIGHT YEAR SURVEY OF CESAREAN SECTIONS AT THE WILLIAM H. COLEMAN HOSPITAL

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THE William H. Coleman Hospital was formally dedicated by an address by Dr. Palmer Findley in October, 1927. The institution was founded by the donor for the care of obstetrical and gynecological patients at Indiana University, as well as for teaching in these subjects. The material for this survey includes all cesarean sections done at this institution from its origin up to January 1, 1936, a period of 8 years and 2 months. The number of available beds for obstetrics is: ward, 27 beds; private floor, 12; while 4 patients can be cared for in the isolation unit.

Maternal mortality in cesarean section depends upon several factors and if our national mortality rate is to be lowered, it is probable that study of these factors in individual institutions as well as community statistics, may point the way to lower national figures. Particularly is this so, if tremendous mortality figures have been greatly improved by facts easily discernible by study of these statistics. Among the factors involved in cesarean section mortality in an institution are the personnel of the staff, the material of the individual institution, the incidence of cesarean section, and the types of operations performed. If, over a period of years, the first three factors remain largely unchanged and the mortality rate is greatly lowered by the wider adoption of safer types of operation, it would only be reasonable to assume that the same would apply to national mortality rates.

The active staff of the Coleman Hospital has been composed of men trained at various institutions, such as New York Lying-in, Boston Lying-in, Chicago Lying-in, Presbyterian Hospital of Chicago, etc. It is only natural that viewpoints at times have been at variance. Of the total of 366 sections done during this period, not including one postmortem section, 5 men have personally performed 285 of the sections. Of the remainder, 20 have been done by 3 other members of the staff, 9 by surgeons not on the obstetrical staff and the remainder by residents at the institution. Since the formation of the American Board of Obstetrics and Gynecology in 1931, all ward sections have been done by or under the supervision of diplomates of this board. The private floor of the institution has been open to the profession, although the majority of patients were those of the staff.

The material of the institution has been threefold, first private patients; second, ward patients from the prenatal clinics of the institution; and third, pathological cases, the patients being referred to the ward by doctors both in the city and from over the state, the majority however, coming from central Indiana. At times our available space has been so limited that only primiparæ and multiparæ in whom we anticipated complications were accepted at prenatal clinics. If space is available no pathological case has been refused admittance to the ward, unless she can afford a private doctor. Much of the material consists of emergency cases, in which we have not seen the patients before admission. Naturally this type of material leads to a much higher incidence of cesarean section than is to be expected in institutions having almost complete prenatal supervision and large enough to take care of all applicants.

INCIDENCE OF CESAREAN SECTION

During the period of 8 years and 2 months, described, there were 7,368 patients at or past viability delivered. The number of cesarean sections during this period was 366, an incidence for the entire period of 1 to 20.1, or 4.8 per cent. It is of interest to know that the incidence at Chicago Lying-in was recently given as 5.6 per cent by Daily. During this time a home delivery service has been super-

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vised by members of this staff. Each year between 1000 and 1500 cases have been delivered in this service. Some of the patients with pathological condition from this service have been sent to the Coleman Hospital, but the greatest number have gone to the Indianapolis City Hospital. Though the inclusion of these figures would greatly reduce our incidence of cesarean section, they cannot be rightfully included. However, it must be emphasized that this service is a university service and is supervised by members of the Coleman Hospital staff.

The incidence by years of cesarean sections in the hospital cases is as follows:

TABLE I.—INCIDENCE OF CESAREAN SECTIONS

Year	Sections	Cases	Incidence	Percentage
1927 (2 months)	5	81	1 : 16.2	6.1
1928	33	679	1 : 20.5	4.7
1929	32	859	1 : 27.7	3.6
1930	47	1098	1 : 23.3	4.2
1931	62	1101	1 : 17.7	5.6
1932	52	869	1 : 16.7	5.9
1933	44	856	1 : 19.4	5.1
1934	43	910	1 : 21.1	4.7
1935	48	915	1 : 19.	5.2

Total incidence, 4.8 per cent.

MATERNAL MORTALITY

At the start of the institution one of the other staff members and the author were convinced of the superiority of the low cervical section or laparotrachelotomy. Through association with Dr. DeLee at the Chicago Lying-in Hospital the author believed that it was the operation of choice; my colleague from the New York Lying-in had probably been convinced indirectly by the teaching of Dr. Beck. However, much as we tried, we could not "sell" the other members of the staff. Strange as it may seem, the man who did more than anyone else to lower our maternal mortality rate was not a member of the staff but he visited us, demonstrated the transverse cervical cesarean section, and succeeded in convincing the staff while we who believed in the superiority of low cervical cesarean had failed to do so. I refer to Dr. Louis Phaneuf who visited the institution in 1931. Previous to 1931 there had been 117 sections with 13 deaths, a mortality rate of 11.1 per cent. Following this and including 1931 to January 1, 1936, there were 250 sections with 12 deaths, a mortality rate of 4.8 per cent or not including 1931, there was a mortality rate of 3.7 per cent for the 187 sections in the years 1932, 1933, 1934, and 1935.

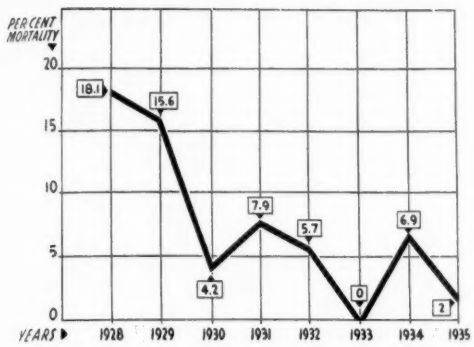
TABLE II.—TOTAL SECTIONS

Year	Total sections	Brod-head	Classic	Laparotrachelotomy		Porro
				Longitu-dinal	Trans-verse	
1927	5		2	3		
1928	33	1	27	5		
1929	32		24	8		
1930	47		36	9		2
1931	62		33	7	22	1
1932	52		32	2	18	
1933	44		29	7	8	
1934	43		22	3	17	1
1935	48		21	3	23	1
Total	366	1	226	47	88	5

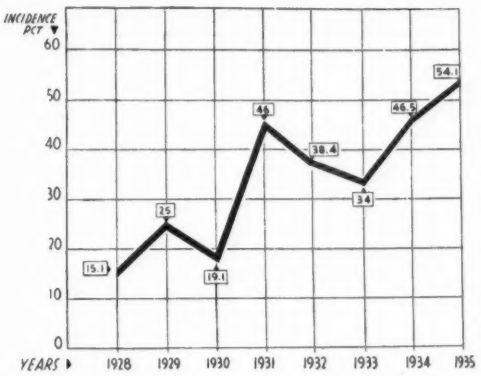
TABLE III.—MATERNAL DEATHS

Year	Classic	Brodhead	Laparotrachelotomy		Porro
			Longitu-dinal	Trans-verse	
1927	0	0	0	0	0
1928	4	1	1	0	0
1929	4	0	1	0	0
1930	2	0	0	0	0
1931	4	0	0	0	0
1932	3	0	0	1	0
1933	0	0	0	0	0
1934	2	0	0	1	0
1935	0	0	0	1	0
Total	19	1	2	3	0
Mortality, per cent	8.4	100	4.2	3.4	0

Table II shows the various types of sections done during this period. The one operation designated as Brodhead was a peritoneal exclusion operation with attempt to wall off the peritoneal cavity by suture of the parietal peritoneum to the uterus before incision into the latter. The classic operations for the most part were low classic operations with the



Graph 1. Cesarean section mortality by years.



Graph 2. Incidence of low operations to total.

abdominal incision below the umbilicus. The longitudinal low cervical operations were that type advocated and described by DeLee and Beck. The transverse low cervicals were all done with the Phaneuf technique. By adherence to this technique there was no difficulty encountered in the approximation of the upper uterine flap to the lower such as found by Stein and Leventhal in the operations performed at Michael Reese Hospital of Chicago. Especially in those cases where the lower uterine segment was not distended by the presenting part, occasionally increased bleeding over the longitudinal incision was encountered. This type operation seems to have a distinct advantage over the longitudinal incision in those cases having very short lower uterine segments and is especially satisfactory in many cases of the elective type in which the lower uterine segment is not fully developed. As the author sees it, it is always preferable to have the entire uterine incision in the lower uterine segment.

Table III gives the maternal deaths according to years and the type of section employed. There is no corrected mortality. It can readily be seen that in this series, the maternal mortality in the low cervical type section has been less than half that of the classic section in spite of the fact that the low cervicals were done for the most part on far poorer risks than the classics.

Graph 1 shows the cesarean section mortality according to years while Graph 2 shows the incidence of low cervical operations to total cesareans for the same years. In general it will be seen that as the percentage of low cervical operations increased, the percentage of cesarean deaths decreased.

INDICATIONS

Table IV gives the various indications for cesarean section in this group of cases and a study of the most frequent indications is of especial interest.

Contracted pelvis or cephalopelvic disproportion. For this indication, section was done 126 times. Almost invariably in these cases, a trial labor was resorted to. The duration of labor varied considerably. However, there were few cases in which patients were permitted to go to complete dilatation, the usual

TABLE IV.—INDICATIONS

Indication	Number of cesarean
1. Contracted pelvis	126
2. Previous section	99
3. Placenta prævia	29
4. Non-convulsive toxemia	35
5. Eclampsia	17
6. For sterilization	9
7. Heart conditions	8
8. Cervical dystocia (1 carcinoma of cervix)	5
9. Abruptio placentæ	5
10. Fibroids	5
11. Ruptured uterus	3
12. Previous dystocia	5
13. Prolapsed cord	3
14. Fetal distress	2
15. Previous plastics	4
16. Toxic goiter	2
17. Age	2
18. Miscellaneous	7

TABLE V.—SECTIONS FOR CONTRACTED PELVIS (TEST OF LABOR)

	Classic		Laparotrachelotomy			
			Longitudinal		Transverse	
	Cases	Deaths	Cases	Deaths	Cases	Deaths
Private floor	39	2	17	1	16	1
Ward	16	3	13	1	25	0
Total sections	55	5	30	2	41	1
Mortality, per cent	9.1		6		2.4	

Total low cervical mortality—4.2 per cent.

custom of Danforth. Many times we have seen delivery take place from below after a trial labor, when if we were doing elective cesarean section because of pelvic contraction, abdominal delivery would have been resorted to. This indication also included 14 cases of breech presentation, 3 cases of face presentation with chin posterior, and 1 brow presentation. Occasionally increase in size of babes may make it necessary even to perform sections in multiparæ. For instance, in Case 9410 patient had had three babes, weighing respectively 7, 9, and 9 pounds. This time the patient was given a complete test of labor to complete dilatation of the cervix and yet there was marked overriding and the head would not enter the pelvis. This babe was 57 centimeters long and weighed 10 pounds and 3 ounces. This case was the author's and cesarean section was not resorted to until even after artificial rupture of the membranes, engagement did not occur.

Though the pelvic inlet can be accurately measured by means of the newer x-ray methods, still we are unable to forecast accurately the type of pain that the patient will have or the moldability of the babe's head. Given two borderline pelves of the same dimensions and with the same size babes, one may deliver through the normal canal while for the other, that route would be an impossibility. In our experience, pelves with enough contraction of the outlet to warrant cesarean section are few and far between.

It is now conceded by most authorities that to do classic cesarean after a trial labor, even though it be conducted properly without vaginal examination, is a very dangerous procedure. At the Coleman Hospital it has been shown that the low cesarean section is a much safer procedure in cases of this type. In fact much of the high mortality for the first 2 or 3 years of the hospital's existence was due to failure to use the safer methods in cases having had test of labor (Table V).

Twenty multiparæ were in this series. Eight secundiparæ had lost their first babe at delivery. A quadripara had lost all previous babes at delivery. The others were subjected to cesarean section because of the size of the babes. In 3 cases, all primiparæ, forceps had been applied before patients were admitted to the hospital but the babes were in good condition. The low cervical mortality of 4.2 per cent when compared with 9.1 per cent for classics leaves no doubt as to the better operation in patients having had tests of labor (Table VI).

Previous section. With the incidence of rupture of the uterus after classic section, about 4 per cent, we have felt that especially in patients having had classic section, cesarean section was the safest procedure in those patients never having had a babe through the normal canal and especially so if the section had been performed for contracted pelvis or if a definite wound infection followed. We know of no way to evaluate the strength of the uterine scar before operation. This group is typical of the elective section cases. No patient had had more than two previous sections.

As given in Table VII, 20 patients who had low cervical operations at repeat sections lived while of the 79 who had classic sections, 3 died. Elective section should have a very low mortality, yet it must be realized that definite increased risk is taken over delivery from below. Of the 99 patients in this group 60 were sterilized—resection of the proximal end of the tubes and a wedge of the uterine cornu was the method usually employed.

No adhesions were noted in patients having previously had low cervical operations, while many of those having had classic sections showed dense, thick adhesions.

The patient who died from intraperitoneal hemorrhage had had a previous transverse cervical operation. At autopsy the scar of

TABLE VI.—HOURS OF TRIAL LABOR, 41 RECORDED

	Case number	Hours	Type section	Highest temperature
6 hours or less	386	3	Classic	101
	1048	5	Classic	*
	6875	6	Classic	100.6
6 to 12 hours	361	12	Longitudinal low cervical	100
	577	12	Classic	104
	1575	7	Transverse cervical	100.6
	4526	10	Classic	102.6
	3485	12	Transverse cervical	101
12 to 24 hours	555	18	Longitudinal low cervical	101
	10510	21	Transverse cervical	99.5
	8936	14	Transverse cervical	103
	3490	24	Longitudinal low cervical	104.5
	752	24	Classic	101
	562	14	Longitudinal low cervical	103.6
	1461	20	Classic	104
	1542	24	Transverse cervical	101.6
	4933	24	Transverse cervical	102
	5921	19	Transverse cervical	102†
	5289	22	Transverse cervical	105.6
	8265	18	Transverse cervical	102
	1408	20	Classic	101
	3199	20	Longitudinal low cervical	103.4
24 to 48 hours	2215	36	Longitudinal low cervical	104
	1853	31	Classic	104.5
	2038	30	Longitudinal low cervical	105
	2215	36	Longitudinal low cervical	104
	5086	48	Classic	105.4
	10108	36	Transverse cervical	100
	430	36	Transverse cervical	101
	196	48	Longitudinal low cervical	102.5
	956	38	Transverse cervical	103.5
	1627	38	Transverse cervical	102.6
	2076	30	Transverse cervical	102
	5484	36	Classic	103
	7502	36	Transverse cervical	105
	7720	26	Transverse cervical	103.8
	7703	26	Transverse cervical	100.6
	6847	28	Transverse cervical	102
	5496	33	Transverse cervical	104.6
Over 48 hours	1569	62	Transverse cervical	101
	622	54	Transverse cervical	103

*Died, peritonitis.
†Packing retained 16 days.

TABLE VII.—INDICATION—PREVIOUS SECTION (ELECTIVE)

	Classic	Laparotrachelotomy Longitudinal	Laparotrachelotomy Transverse
Ward	51	4	8
Deaths	1*	0	0
Private floor	28	2	6
Deaths	2†	0	0

*Embolism.
†Intestinal obstruction, postoperative hemorrhage.

TABLE VIII.—INDICATION—PLACENTA PRÆVIA

	Classic Cases	Classic Deaths	Laparotrachelotomy Longitudinal cases	Laparotrachelotomy Transverse cases	Total cases
Private floor	3	2	1	0	4
Ward	15	1	2	8	25
Total	18	3	3	8	29

There were 3 maternal and 3 fetal deaths.

this operation was just visible. In Case 555 the author performed a third section, longitudinal laparotrachelotomy. This patient had previously had one classic section and one longitudinal low cervical section. The scar of the latter operation was barely perceptible while the fundal scar of the previous operation was depressed and thin.

Placenta prævia. Most obstetricians agree that in a patient at term but not in labor, who has a placenta prævia of the central or lateral type and a thick undilated uneffaced cervix, it is safer to effect delivery by cesarean section. On the 29 sections during this period for placenta prævia, 7 were primiparæ, the others multiparæ: 1, a nonipara; 1, a decipara; and 1, an undecipara. Other multiparæ were treated by bag, Braxton Hicks version, or internal podalic version. Table VIII gives the results of cesarean sections done for placenta prævia.

One patient on private floor was admitted in shock and bleeding very profusely. A classic section was done and the patient died of peritonitis. The other death on private floor was due to a postpartum hemorrhage 3½ hours after she returned to her room. The ward patient died from septicemia after she had had a classic operation.

Bill has pointed out the importance of transfusion and the dangers of postpartum hemorrhage in placenta prævia and has called attention to the lessened tendency to postpartum hemorrhage in those patients treated

by cesarean section. The patient who died of postpartum hemorrhage after section was not packed at the time of operation. This should always be done in cases of abruptio placentæ and placenta prævia.

Whenever a patient with placenta prævia comes to the ward, she is immediately taken to the delivery room. Blood is drawn for typing and fluid is given intravenously if necessary. One room is set up for cesarean section and the other for delivery from below, insertion of bag, etc. The procedure to be carried out is determined only after a careful vaginal examination to determine the state of the cervix and the degree of prævia. The practice of omitting the vaginal examination is to be condemned because occasionally a patient at term will have bleeding from the vagina, especially if labor is just starting, without the presence of placenta prævia. A vaginal examination will save these women from unnecessary cesarean section.

The possibility of placenta accreta or increta with placenta prævia should always be borne in mind. If the condition exists to any extent, the uterus must be removed.

Non-convulsive toxemia. Cesarean section has been reserved for those cases of fulminating pre-eclamptics not responding or rapidly growing worse under conservative treatment. Consultation between two or more staff members was had in most cases before section was done. Decision to operate was largely made on the clinical picture though blood chemistry, especially uric acid determination and carbon dioxide combining power was often helpful. We feel that we have saved lives by doing cesarean sections on primiparæ not in labor and having thick, closed cervices, who were rapidly growing worse on conservative treatment. In this condition, local anesthesia is the anesthetic of choice. In this series, 35 sections were done for this indication with 1 death. The death was in a patient with recurrent toxemia. She was a quadripara who had had convulsions in each of her former pregnancies. At about 8 months she appeared in the prenatal clinic with a blood pressure of 170/110 and with only a trace of albumin. A low classic section and sterilization was done under local anesthesia. The patient went into coma and died within 48 hours. The most noteworthy findings at autopsy were pulmonary edema and marked periportal necrosis of the liver.

Table IX shows results as to type of operation. In 6 cases local infiltration anesthesia was used, 1 spinal anesthesia, and in the remainder nitrous oxide oxygen supplemented by ether.

TABLE IX.—INDICATION—NON-CONVULSIVE TOXEMIA

	Classic	Laparotrachelotomy Longitudinal	Transverse
Private floor	12	3	6
Ward	12*	0	2

*1 death

Eclampsia. Conservative treatment is the treatment of choice after convulsions or coma. Occasionally in desperate cases rapidly growing worse, we have employed local cesarean section. In a few cases in which the patient was moribund and there was a reasonable chance of getting a live babe, section was done in the interest of the babe. As usual with this indication, mortality has been tremendous and yet occasionally a patient who seemed surely destined to die, would live.

TABLE X.—INDICATION—ECLAMPSIA

	Classic		Transverse Cervical	
	Cases	Deaths	Cases	Deaths
Private floor	6	1	0	
Ward	9	3 mothers 2 babes	2	1 mother 1 babe

For sterilization. It is a much safer procedure to sterilize, when indicated, 3 to 6 months after delivery. Many times however, it has been our experience that often these patients will return pregnant again before the operation can be performed. Cesarean section was done for sterilization with no other indication, nine times. Indications for sterilization were chronic nephritis, severe hydronephrosis, active pulmonary tuberculosis, epilepsy, and mental deficiency. Fortunately no deaths occurred from this questionable procedure.

Organic heart disease. Because of heart disease section was done 9 times and 3 deaths followed. In all the deaths mitral stenosis was present. One patient died with lobar

pneumonia, and the 2 others with heart failure. All patients with heart disease had the benefit of consultation by a cardiologist.

Abruptio placentæ. Patients with severe types of abruptio placentæ were subjected to cesarean section. There were 5 cases. All mothers lived and all babes died except in 1 instance in which live twins were delivered. This patient was in labor in the ward when the classical picture of abruptio placentæ occurred. One of the staff was in the hospital at the time and the patient was immediately subjected to cesarean section.

Fibroids. In 5 instances fibroids blocked the birth canal, and cesarean section was done in all 5. Two of the operations were Porro and three were classic. One patient succumbed in this series, and it is probable she could have been saved by the Porro operation. In spite of the fact that pus was present in the abdominal cavity from a degenerating fibroid, a classic section was done and the patient died of peritonitis.

Ruptured uterus. As far as we know, none of our sections has ruptured. However, in this 8 year period we have had 3 cases of rupture of the uterus. One was a rupture at the site of the scar in a patient who had had a classic operation. The second case was a patient who had had a normal delivery and later a cesarean section by an outside surgeon. The third case was one of spontaneous rupture in a scar when attempt at forceps delivery had been made and pituitrin had been given. All mothers recovered and all babes were stillborn.

MATERNAL DEATHS

Listed below are brief notes taken from the charts of all patients dying after cesarean section.

1928

1. Case 684. Primipara, ward, aged 25 years, had a classic section after a trial labor and with membranes ruptured for several hours. She died of peritonitis on the fourth day.

2. Case 809. Quadripara, private, aged 39 years, had a classic section because of central placenta prævia. A postpartum hemorrhage started 20 minutes after she was returned to her room. She died 3 hours and 35 minutes after delivery.

3. Case 1015. Primipara, private, aged 34 years, had an elective classic cesarean section because of a deformed pelvis due to tuberculosis of the lower spine. The incision opened after operation necessitating secondary closure including peritoneum. The patient died of infection and myocardial failure. Highest temperature was 100 degrees.

4. Case 1048. Primipara, ward, aged 16 years, because of pelvic contraction, had a cesarean section with low classic incision 5 hours after the onset of labor and with membranes intact. She died on the twentieth day after operation of peritonitis. Autopsy showed uterine necrosis at the line of incision.

5. Case 1190, secundipara, private, aged 41 years, was operated upon after 4 days' trial labor, with membranes ruptured many hours. A longitudinal low cervical section was done and the patient died of peritonitis.

6. Case 2007, secundipara, private, had cesarean section 2 days after an attempted bag induction. The first babe had been lost in a forceps operation and this time the fetal heart had gone to 170. A Brodhead type of peritoneal exclusion operation was done. Patient died of peritonitis and thrombophlebitis with embolism.

Mortality for 1928, 18.1 per cent.

1929

1. Case 4598, primipara, ward, aged 27 years, was admitted in a moribund condition. She had not attended a prenatal clinic and had had several convulsions before admittance. An antemortem classic section was done. Patient was cyanotic, chest was filling with mucus, pulse was 140, and temperature, 104 degrees. She died of eclampsia.

2. Case 3497, secundipara, private, had delivered her first babe from below. After 15 hours of labor, she went into convulsions. Her doctor called a general surgeon who immediately did a classic section under ether anesthesia. She died of eclampsia.

3. Case 4190, secundipara, private, aged 29 years, had a terrific hemorrhage from placenta prævia before admittance to hospital. A classic section was done and the patient died of peritonitis and pulmonary embolism.

4. Case 2883, primipara, private, aged 33 years, upon whom a classic section was done after 30 hours of labor and 1 vaginal examination, died with paralytic ileus.

5. Case 4757, secundipara, ward, aged 26 years, had lost her first babe at delivery. A longitudinal low cervical operation was done after trial labor. Operation was an hour in duration. While closing the abdomen patient stopped breathing without signs of circulatory failure. All efforts at artificial respiration failed although the heart continued strong for several minutes. No autopsy permitted. Death was evidently caused by the anesthetic.

Mortality for 1929, 15.6 per cent.

1930

1. Case 6588, primipara, private, with chronic valvular heart disease was operated upon by classic section and died of lobar pneumonia.

2. Case 5626, primipara, ward, aged 18 years, had an elective classic section because of placenta prævia and toxemia. She developed eclampsia and died of septicemia. The Staphylococcus aureus was found in the blood cultures.

Mortality for 1930 was 4.2 per cent.

1931

1. Case 9796, secundipara, ward, aged 44 years, was subjected to cesarean section because of disproportion plus a pre-eclamptic toxemia. Blood pressure was 180/115 with marked edema and headache. A classic section was done and the patient died on the tenth day after operation, with pulmonary embolism demonstrated at autopsy.

2. Case 9397, quadripara, ward, aged 37 years, was admitted, with recurrent toxemia. She had had convulsions with all previous pregnancies. Blood pressure was 170/110; albumin, trace, was noted. A classic section and sterilization was done under local anesthesia. Patient went into coma and died 2 days later. Autopsy showed marked periportal necrosis of the liver and atheroma of the aorta.

3. Case 9593, quintipara, ward, aged 32 years, had an elective classic section and sterilization was done because of myocarditis and mitral stenosis. She died 10 days after section with pulmonary edema and heart failure.

4. Case 8459, septipara, ward, aged 36 years. Patient was admitted to hospital in deep coma, with eclampsia. She had had 8 or 10 convulsions and urine showed albumin, 4 plus. The doctor who sent her first saw her in convulsions. She was seen by 3 staff men; a transverse section was done under local anesthesia. She died of toxemia and bronchopneumonia.

5. Case 8498, primipara, ward, aged 18 years, was admitted in comatose and cyanotic state. She had had several convulsions. She was a prenatal patient. Monday of admission patient had done a large washing. A classic cesarean section was done. Patient died of toxemia.

Mortality for 1931 was 7.9 per cent.

1932

1. Case 86, primipara, ward, aged 32 years, had 26 hour trial labor with no engagement. The birth canal was blocked with 3 large fibroids. A classic section was done. Pus was found in the abdominal cavity from a degenerating fibroid. A fibroid the size of a baseball was excised from the uterus. Patient died of peritonitis.

2. Case 11302, tripara, ward, aged 38 years. Patient entered hospital in coma. Blood pressure was 195/125; non-protein nitrogen, 47, albumin, 3 plus. A classic section was done after 6 hours of labor and after the membranes had been ruptured artificially. Patient died of eclampsia.

3. Case 11138, secundipara, ward, aged 28 years, had had previous section for disproportion. A classic section and sterilization was done. Patient died 3 hours later with pulmonary embolism.

Mortality for 1932 was 5.7 per cent.

1933

No maternal deaths.

Mortality for 1933 was nil.

1934

1. Case 5638, primipara, private, aged 23 years, was referred to one of the staff by an outside doctor. Forceps had failed to produce results in the home with prolonged chloroform anesthesia. Pituitrin had been given. A transverse cervical cesarean was done. Patient died of infection plus acute yellow atrophy. No autopsy was obtained.

2. Case 5548, quadripara, private, aged 31 years, had had two previous sections. Elective classic section plus sterilization was done. Patient died after 25 days with intestinal obstruction and lobar pneumonia.

3. Case 5208, secundipara, private, aged 20 years, had had previous transverse cervical cesarean section. The operator chose the classic section. The patient died 4 hours later from postpartum hemorrhage. At autopsy 800 cubic centimeters of blood was found in the abdomen.

Mortality for 1934 was 6.9 per cent.

1935

1. Case 9347, primipara, private patient of the author's, aged 27 years, had mitral stenosis of long standing. There had been good compensation throughout pregnancy. After 12 hours of labor, patient went into decompensation. A transverse cervical cesarean was done, and live babe delivered. Mother died in 12 hours of heart failure. Patient had been seen throughout pregnancy and labor by a cardiologist.

Mortality for the year 1935 was 2 per cent.

MORBIDITY

Morbidity is defined in most medical dictionaries as the state of the patient, or degree of sickness, or condition of being diseased. According to present standards, the temperature alone is taken to express this. In cases of infection this is probably the best index as to the condition of the patient. In hemorrhage, certainly the hemoglobin determination would be more indicative of the true state while in the toxemias blood pressure readings and quantitive albumin determinations would offer more indication of the patient's condition. It is well known that many patients go through their stay in the hospital with normal temperature and yet are left in terrible condition, gynecologically.

The standard adopted by the American Committee on Maternal Welfare considers normal any rise in temperature above 100.4

TABLE XI.—TEMPERATURE RANGE

	100 or below		100–101	101–102	102–103	103–104	Above 104
	Cases	Per cent					
Classic	24	10.6	65	69	31	18	18
Longitudinal low cervical	5	10.6	12	11	11	3	5
Transverse	12	13.6	22	29	15	5	5
Porro	0		1	1	1	0	2
Brodhead	0		0	0	1	0	0

TABLE XII.—CAUSE OF MORBIDITY (81 CASES)

		Laparotrachelotomy		Classic	Porro	Brodhead
		Longitudinal	Transverse			
Pyelitis	31	7	7	16	1	
Phlebitis	7	1	2	4		
Peritonitis	6	1		4		1
Wound infection	11	1	5	4	1	
Ileus	2			2		
Lobar pneumonia	6		3*	3		
Bronchopneumonia	3		2*	1		
Pleurisy	1			1		
Pelvic abscess	2		1	1		
Septicemia	1			1		
Pulmonary embolism	2			2		
Bronchitis	4		1	3*		
Hyperthyroidism	3		1	2		
Dehydration	1		1			

*1 local

TABLE XIII.—CAUSES OF DEATH

		Laparotrachelotomy		
	Classic	Longitudinal	Transverse	Brodhead
Peritonitis	4	1		1
Postpartum hemorrhage	1		1	
Infection and septicemia	2		1	
Eclampsia	5		1	
Ileus	2			
Anesthesia		1		
Embolism	2			
Heart	1		1	
Lobar pneumonia	1			

degrees on any 2 days, exclusive of the first 24 hours, oral temperature taken every 4 hours. Yet a patient may come under this standard of normal and yet have been close to death.

For instance Case 9371 was a severe pre-eclamptic whom I saw in consultation after she had had 1 week of conservative treatment. She was becoming worse in spite of intravenous glucose and sedation. As she was a primipara about 2 weeks from term with a closed thick cervix, cesarean section was done. The operation took about 45 minutes and there was very little blood loss, a longitudinal laparotrachelotomy being done. Shortly afterward she went into severe collapse, with cold clammy extremities, a blood pressure so low it could hardly be recorded and soon had a temperature of 106 degrees and a hardly perceptible radial pulse. Fortunately, she responded to treatment and after the first 24 hours, never had a temperature up to 100 degrees. I have never seen a patient closer to death, and yet she would not be recorded as being morbid by the standard advocated by the American Committee on Maternal Welfare.

In this series of cases, rectal temperatures were invariably taken for the first 36 to 48 hours. In Table XI is given the range of temperatures, including the first 24 hours.

It is significant that peritonitis occurred in only one low cervical case, a case of 4 days' labor with membranes ruptured 48 hours. In any hospital taking neglected or mishandled cases, the type section is always a problem, especially in those patients in labor many hours, with membranes ruptured a long time and with frequent vaginal examinations sometimes without gloves or after attempts at delivery from below. If the babe is alive and apparently in good condition with the pelvis so contracted that delivery of a live babe from below is impossible, the Porro operation would seem to give greatest protection to the mother, not only because of removal of the infected organ but also because of ligation of the uterine vessels. The only case of peritoneal exclusion operation or marsupialization in this series died. Recently in another it was done with the peritoneum and fascia sutured to the uterus before incision into it. This patient recovered after a stormy puerperium. Whether the Latzko operation is safer than the laparotrachelotomy in these cases is still questionable. The initial spill is probably

not the greatest factor as we know the peritoneum will usually stand one severe insult but with repeated insults, peritonitis will often occur, for instance, in classic sections with the uterine incision infected and leaking. The author is inclined to believe that he would rather trust the resistance of the lower peritoneum to an infectious spill than to trust the resistance of the pelvic connective tissue. It is probable that infection after cesarean often originates from an endometritis, the infection continuing to the uterine incision, and then to the peritoneum. Certainly these cases are minimized in the low cervical operations.

TABLE XIV.—FETAL MORTALITY

Indications for section	Babes died
Previous section	2
Placenta prævia	3
Non-convulsive toxemia	2
Eclampsia	3
Abruptio placentæ	4
Prolapsed cord	1
Ruptured uterus	3

As there were 6 sets of twins delivered in this series, the total of babes were 372, which with 18 deaths gives a fetal mortality of 4.8 per cent.

SUMMARY

All cesarean sections from the start of the Coleman Hospital in October, 1927, to January 1, 1936, have been reviewed. There has been no great change in incidence during this period, the lowest incidence for a full year being 3.6 in 1929, and the highest 5.9 in 1932. Incidence for the entire group is 4.8 per cent. During this period the staff has been largely unchanged. The material is largely pathological and has been unchanged in character. There has been a marked increase in the incidence of low cervical cesarean section or laparotrachelotomy since 1931. Accompanying the increased incidence of this type operation there has been a decided drop in maternal mortality from cesarean section. Maternal mortality from cesarean section before 1931 was 11.1. Doctor Phaneuf's visit was in 1931. For the years 1932, 1933, 1934, and 1935 the mortality rate was 3.7 per cent. The mortality rate for all classic operations during the 8 year period was 8.4 per cent. The rate for all low cervical sections, including longitudinal and transverse incision was 3.7 per cent.

The most frequent indication was contracted pelvis. Most of these cases had the test of labor. The next most frequent indication was previous section and practically all of these were elective sections. For the indication, contracted pelvis, classic section gave a mortality of 9.1 per cent and low cervical 4.2 per cent. For the indication, previous cesarean section, i.e. elective cases, there were no deaths in 20 cases having low cervical operations while there were 2 deaths in 79 classic operations, a mortality for the classic of 3.7 per cent. For placenta prævia there were 18 classics with 3 deaths and 11 low cervicals with no deaths. For non-convulsive toxemia there were 35 sections with 1 death, while in eclampsia there were 17 sections with 5 deaths. Five cases of abruptio placentæ were sectioned and all recovered. Three cases of rupture of the uterus recovered. The most frequent cause of morbidity was pyelitis. The most frequent cause of mortality was peritonitis and infection. The fetal mortality was 4.8 per cent.

CONCLUSIONS

1. The greatest single factor in the reduction of cesarean section mortality at the Coleman Hospital, has been the wider adoption of low cervical cesarean section.

2. The low cervical operation is safer than the classic, not only in cases of patients having had tests of labor but also in elective cases. In the latter type patient and in other patients having short lower uterine segments, the transverse incision with the Phaneuf technique is a very satisfactory procedure.

3. By study of these statistics, it is only reasonable to assume that if low cervical operations could be substituted for the classic operations in this country, the mortality from abdominal deliveries would be cut in half, a prediction made by DeLee in the 1933 *Year Book of Obstetrics and Gynecology*.

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RENAL TUBERCULOSIS

With Special Reference to Follow-Up Results in the Squier Clinic

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DURING the 7 year period from January 1, 1928, to January 1, 1935, in the Squier Urological Clinic, 96 tuberculous kidneys were removed at operation. The present study was primarily undertaken to determine the status of these patients at the present time by reviewing the follow-up reports. Our study in turn led to a complete analytical summary. The conclusions reached under the usually accepted headings in such analyses vary but little from similar reports of other clinics, and will therefore be only briefly noted. The follow-up results, death analyses, and the presentation of a few unusual cases are given special attention as being of possible value in the study of this subject.

Sex. Of 96 patients, 56 were males, 40 were females.

Operation. The right kidney was removed in 50 cases, the left in 46 cases. Complete ureterectomy was done only 3 times.

Age. The youngest patient was 13 years, the oldest 76 years.

Age in years	Cases
Less than 20	9
20 to 29	18
30 to 39	38
40 to 49	16
50 to 59	11
60 to 69	3
70 to 80	1

Race. There were 53 Gentiles, 22 Jews, 3 Negroes, 16 Italians, 1 Mexican, and 1 Chinese. This incidence probably represents a cross section of our clinic rather than individual susceptibility to the disease.

Symptomatology. Frequency of urination was noted in 74 instances, the duration varying from days to years. Those without this symptom usually had a very early lesion or a blocked kidney. *Urgency* and *dysuria* were as a rule present in advanced lesions of the bladder.

Pain was noted in 37 cases. This was more than we had expected judging from our general impression and from other reports on this subject. For the most part pain was localized in the flank but 4 patients experienced a radiation of the pain in the groin similar to that seen in renal colic.

Hematuria was mentioned by 37 patients. From the follow-up study of these cases, this symptom had no prognostic value except where bleeding occurred from very early lesions. In these cases the hematuria led to an early nephrectomy before much renal or bladder involvement had occurred. For example, 2 patients were referred on account of red blood cells being found in routine life insurance examinations of the urine. Both have perfect follow-up results 4 and 5 years after nephrectomy.

Cystoscopic findings before pyelography suggested tuberculosis to the examiner in 86 cases.

Pyelograms. Where obtainable, pyelograms were diagnosed as tuberculosis 73 times. In the earlier years of this study we did not have the use of intravenous pyelography. The number of destroyed or dead kidneys, where we could not pass a catheter by a ureteral block or where the intravenous injection of skiodan or diodrast gave no shadow, was 21. In view of this fact the next caption is interesting, and satisfactorily so to this clinic.

Tubercle bacilli in the urine were found microscopically where separate kidney specimens were obtained in 68 of 70 possibilities. Of the 2 specimens in which the bacilli were not found, 1 was in a patient with an early lesion which gave no symptoms. The other was in a tuberculous kidney composed mostly of fat replacement and no cavities. Our experience with this method of determining the presence of the tubercle bacillus in the urine has been so uniformly good that guinea pigs are no longer used. In the cases in which kidney specimens were not obtainable the diagnosis was made

From the J. Bentley Squier Urological Clinic, Presbyterian Hospital.

from the history, cystoscopic appearance of the bladder, and by pyelograms, intravenous or retrograde.

Co-existing extrarenal tuberculosis was found in the lungs of 17 cases, in the epididymis in 9 cases, in the spine in 2 cases, of the hip, 2 cases; there was 1 patient in whom the breast and sternum were involved.

Pathological diagnosis. Examination of the removed kidneys showed 21 to be destroyed and functionless. Three showed diffuse changes with tubercles but no cavitation. Three showed only small early cavities; 3 were made up mostly of fat replacements; in 3 cases calculi were present. In a patient 76 years old the kidney was greatly atrophied and showed some healing. There were 2 cases of tuberculosis in embryonic kidneys. There was one lesion in one half of a double kidney. One caseous lesion was in a kidney which also showed a large solitary cyst. One kidney had an area of solid calcification 3 by 4 centimeters in diameter. This was reported as tuberculosis by the pathologist although the history and physical findings were negative. This patient came to operation only because of the shadow of this lesion having been found in routine gastro-intestinal x-ray examinations. The remaining kidney showed the usual caseous changes with cavity formation.

Death analyses. Of 96 patients operated upon during this 7 year period, 11 are known to be dead. There were 8 patients who died in the hospital; 3 of these died, 1, 1, and 3 years, respectively, after operation, on being readmitted to the clinic. Five deaths must be included under operative mortality; of these 1 died of pneumonia on the eighteenth day after operation; 1 died 42 days after operation of renal insufficiency, the remaining kidney was found to be hydronephrotic at autopsy. One patient died 48 days after operation of miliary tuberculosis. One died 49 days after operation of bronchopneumonia; the wound was markedly infected and showed no tendency to heal. One died 184 days after operation; this was a young colored woman. Her operative wound opened widely a few days after nephrectomy, and at no time showed any tendency to close, despite sun and light treatments. On the one hundred and sixty-eighth day a fecal fistula developed. In this case, at operation the open end of the ureter slipped away and was not recovered for ligature.

Of the 3 patients who died in the hospital on readmission, 2 were known to have bilateral lesions, and operation was done only in an attempt to make them more comfortable. One, a young Jewish man of 27 years, had a right nephrectomy despite a known infection of the left kidney and of the lung. He was definitely more comfortable for 6 months after this operation, then he suffered pain in the left side and had a generalized edema and died approximately 1 year after the operation from a generalized tuberculosis including a terminal meningitis. The other case in which nephrectomy was done for palliative purposes only, was an Italian male of 32 years. He gave a history of hematuria of 3 years' duration; his right kidney was destroyed; his left specimen showed tubercle bacilli but the function and the pyelogram were apparently normal. After removing the right kidney he did not improve even temporarily. He lived 3 years and 1 month after his operation. The history of the last patient who died in the hospital is of unusual interest because autopsy showed tuberculosis of the adrenal gland, the only instance of this lesion in this series.

The patient was a Negro male of 30 years who after 9 months of urinary distress had his right kidney removed for unilateral renal tuberculosis. He also had a chronic pulmonary lesion. His wound reopened after healing but 1 year later his urological follow-up showed a perfect result. Two years after operation he was readmitted on account of marked weakness and pigmentation changes typical of Addison's disease. He had no urological complaints. Five weeks after admission he died. Autopsy showed tuberculosis of the peritoneum, lungs, and the adrenal gland. The remaining kidney was normal.

The records of the 3 patients known to have died outside of the hospital, show the following:

One was a man of 27 years, whose removed kidney showed fatty degeneration and diffuse calcification. He also had tuberculosis of the left lung with partial collapse. His bladder symptoms which had existed 1 year prior to operation were not relieved and he died 3½ months later in a sanitarium.

The second case was a girl of 23 years with bilateral renal tuberculosis. She also had a diffuse left lumbar abscess and a urinary fistula which developed 1½

years before we saw her following an attack of urinary retention. A left nephrectomy and drainage of the lumbar abscess were done as a palliative measure. The kidney showed an acute tuberculous hemorrhagic nephritis. She lived 6 months only. Toward the end she had a severe bloody diarrhea, so that in addition to her known renal, psoas, and lumbar involvement, the gastro-intestinal tract was probably diseased as well.

The last patient was an Italian male of 34 years, who had his right kidney removed for supposed unilateral tuberculosis. He also had pulmonary tuberculosis and tuberculosis of the epididymis with a fistula. He did not improve and 6 months later his bladder urine showed tuberculosis. Fifteen months after operation he died. Postmortem examination showed tuberculosis of the lungs, the peritoneum, and the remaining kidney.

All of the patients who died were in their twenties or early thirties except one man of 50 years who died of pneumonia. As to the bilateral cases in these reported deaths, it is easy in retrospect to criticize one's having subjected these patients to nephrectomy but under the circumstances it seemed to be the right thing to do. Also, in going over the record of the bilateral cases still alive following the removal of the more diseased kidney, there is some very encouraging reading.

Follow-up reports. In 9 cases we have been unable to obtain any record after operation despite earnest efforts of our social service department both by letter and personal investigation. This may be due in some part to the transient nature of the New York City population. We have follow-up records on 75 cases, 73 of which were supposed to have had unilateral lesions only. These reports are arbitrarily rated by the same method long in use in other departments in the hospital. The anatomical, symptomatic, and economic results are each graded from 1 to 4, 4 being perfect. For instance, 4 4 4 means that the wound is well healed, there are no symptoms, and the individual is able to do a full time job. An attempt is made to follow these cases for at least 5 years; of course, in this present list only those from the earlier years of this series are available for a report of that duration.

The 3 bilateral cases who were subjected to nephrectomy of the more diseased kidney are alive 3, 3, and 1 years after operation. One apparently enjoys good health, 1 is working in Colorado although he has bladder complaints of moderate severity; we rate him 4 2 4. The third has his wound still draining, his symptoms persist, and he cannot work. His rating is 0 2 0.

Of the 73 unilateral cases available for follow-up study, at the end of 1 year 16 were graded 4 4 4; 4 were graded 4 3 4; 6 were graded 4 2 4; 5 were graded 0 3 4. In these last 5 the wound had not entirely healed in 4 and 1 had an incisional hernia. Two were graded 4 2 0.

After 2 years, 12 more cases were graduated to the 4 4 4 class making 28 in all. This cured rating progressively increased each year so that as of today the last records on these 73 patients, varying from 1 to 7 years after operation, show 52 cases in the 4 4 4 class. This rise from 16 the first year and 28 the second year was due to our tracing patients who had not responded to our previous efforts. Also, many of these were private patients and, until this study began, the follow-up data had not been elicited from their doctor's private files for the hospital record. There were 6 patients who for the first year or two improved slowly if at all, but later had a good result. One man showed no improvement in symptoms at first, and 2½ years after operation his bladder showed tubercle bacilli. Four years after operation he was perfectly well, the urine was negative, and he was working at a good job. Five years after operation he was still in good health, but he had a tuberculous epididymis with fistula formation. One woman had little improvement in bladder symptoms until 4 years after operation, since which time she has been free from urinary trouble. In 2 patients it was over a year before their wounds healed. Two were thought to be probably bilateral cases up until 2 years after operation, yet all of these 6 were later in the 4 4 4 class.

Histories like these give real hope where slow postoperative progress would seem to indicate a bad prognosis. In no instance has a 4 4 4 rating had to be changed later.

Another group of 8 patients after 2 years or more were listed as 4 3 4 or 4 2 4 meaning their wounds were firmly healed and they were working, but they still had urinary frequency. The urine was clear in 4 of them, and in 4 it was cloudy. There was a definite contraction of the bladder of varying degrees in all.

In 7 patients our last record was only 1 year after operation, and is consequently of not much value. Four were graded 4 2 4, three 4 3 4, and one 0 2 4 at the end of the year.

Another group of 5 are rated as bad results. There was no improvement in urinary symptoms in any one. Two young men 2 years after operation, in addition to their continued bladder distress had active pulmonary tuberculosis, and 1 had tuberculosis of the epididymis. In the case of 1 woman 5 years after operation, while her general health had not failed, tubercle bacilli were found in her remaining kidney. Another woman of 50 was found to have the remaining kidney infected 2 years after operation, and there were tubercles in the bladder wall. She also had tuberculosis of the breast and sternum. One man of 50 was bedridden for nearly a year after operation without any improvement of symptoms, and his wound was still open. He was transferred to a state hospital.

There were 3 patients who before operation were thought to have renal tuberculosis, but the pathological examinations could not confirm this diagnosis. In 1, the diagnosis was made on account of hematuria and frequency and the finding of a decreased bladder capacity, ulceration seen near the right ureteral orifice, and a functionless right kidney. The kidney showed only chronic nephritis. In the second case, the right kidney specimen showed pus cells, and tubercle bacilli were reported as being found. The pathological diagnosis was acute pyelonephritis with no evidence of tuberculosis. In the third case, a 24 hour specimen was reported positive once, and a pyelogram showed some hydronephrosis of the right kidney. No tubercle bacilli were found in the kidney specimen. Pathological diagnosis was acute nephritis, hydronephrosis, and questionable tuberculosis. Fortunately all 3 have today a 4 4 4 follow-up status. To sum up the known cases of renal tuberculosis who were thought to have unilateral lesions at the time of operation, we have information on 73 at intervals of 1 to 7 years after nephrectomy—52 are in the 4 4 4 class; 8 are in the 4 2 4 or 4 3 4 class after 2 years; 7 rate 4 2 4 or 4 3 4 after 1 year; 5 cases show very bad results; 1 man is well but has hernia of his operative wound.

Inoperative cases. In this 7 year period there were 14 bilateral cases in which patients were not operated upon. Of the 14 only 3 were without tuberculosis elsewhere; 4 were without demonstrable pulmonary lesions.

EVALUATION

Fifty-two excellent results in 73 available in this study of 96 nephrectomies is by no means discouraging. The 11 deaths do not seem out of proportion to the problems presented. There were only 4 so called "operative" deaths. In several bilateral cases patients were operated upon for palliative reasons only. Apparently the existence of tuberculosis elsewhere in the body, the length of time it takes the operative wound to heal, the history of hematuria or the duration of the symptoms before operation, have little prognostic value as to the eventual urological result. While the relief of frequency after operation is encouraging, the persistence of some does not necessarily mean a bad outlook. Some of these patients will maintain perfect health except for the frequency of urination due to a contracted bladder. A few patients may show tubercle bacilli in the bladder urine for as long as 2 years and yet regain good health with relatively normal bladder function. It may well be that when one renal lesion is apparently causing the majority of urinary symptoms, that kidney should be removed if the other kidney is functionally normal, even if the pyelogram is suggestive of tuberculosis; it is the patient's only chance for relief and possibly cure.

Several cases in this series were of particular interest, because a bad prognosis at the time of operation proved wrong in the light of reports several years later. Our general impression as to the outlook for a patient afflicted with renal tuberculosis is more optimistic than it was before this study. This is true for patients where extrarenal disease was shown to be present as well as for those in whom the kidney lesion only could be demonstrated.

Renal tuberculosis must be considered as only part of a generalized tuberculosis or a tendency toward it. Where economic conditions permit, every effort should be made to have the patient guard himself from further manifestations of the disease by the best pos-

sible anti-tuberculosis mode of living. Insistence upon this point seems to be the only way by which we can make future follow-up reports improve upon those of today.

As an example I wish to present the case of a young man whom we saw several years before this series of cases began.

He had a draining suprapubic sinus following an ill advised cystostomy done elsewhere 1 year before we saw him. We found one kidney to be tuberculous and removed it. Later the suprapubic sinus tract was excised and successfully closed, after which he voided for the first time since his first operation. We sent him to the country and did not see him until a year later when he looked well and had gained 30 pounds. His only urinary symptom was slight frequency. Despite our advice he returned to New York City to the same work and living conditions which may have caused his original infection. Within 6 months his urinary symptoms increased, his prostate and both epididymides became involved, a rectal fistula developed and he lost much weight. A roentgenogram of his chest showed a miliary tuberculosis and he soon died. This tragic ending might have been avoided had this patient remained in the country where he was doing so well.

I dwell on this case because it vividly exemplifies two important points: (1) the removal of a tuberculous kidney even where it effects an apparent complete cure is not the only step needed in this disease. (2) The correct after-care must be more seriously stressed if we are to improve our results. Of course, in many cases the economic conditions do not permit postoperative care; in others, however, without being unduly dramatic the doctor can present the risks squarely and insist upon a different basis of life if the patient is interested in living at all. With the co-operation of an efficient social service which we are fortunate enough to have, apparently impossible situations can often be satisfactorily solved.

SUMMARY

A 7 year study of renal tuberculosis in the Squier Urological Clinic is presented.

Special attention is given to death analyses and follow-up reports. The importance of postoperative care is emphasized.

CLINICAL SURGERY

FROM THE DEPARTMENT OF SURGERY, UNIVERSITY OF CALIFORNIA

RECONSTRUCTION OF THE BILE DUCTS

New Method of Anastomosis

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STRICTURES of the common and hepatic ducts, though not unheard of, were of little importance until after our surgical procedure changed from cholecystostomy to cholecystectomy. This more radical procedure involved the exposure of the cystic, and usually of the common, duct and frequently the opening and probing of these ducts for the presence of stones. In the past few years, certain writers (10) have advocated the routine opening and exploration of the common and hepatic ducts when stones were found in the gall bladder, or even in the presence of inflammatory conditions (1). Others (6) have insisted upon the ligation of the cystic duct at, or very near, its union with the common duct to prevent the reformation of gall stones in this stump (2).

When we take into consideration the fact that anomalies of these ducts and of the blood vessels accompanying them are present in from 20 to 30 per cent of all persons (13), it would seem inevitable that these attempted refinements of technique should be accompanied by a certain percentage of accidental injuries. Such injuries range from direct ligation and division of the ducts to those resulting from hemorrhage followed by cicatricial reaction and stricture. Even if the original injury is recognized and repaired immediately, stricture is not entirely avoided; those injuries that are unrecognized tend to swell the number of unexplained deaths (2). Although most strictures of the common and hepatic ducts are regarded as surgical complications of cholecystectomy and its associated procedures, a certain percentage of them occur so long after operation that it is hard to understand how the surgical procedure could be responsible. It is probable that these late strictures are the result of cholangeitis and are similar to those described as having occurred in persons in whom no surgery has been done (8).

While certain clinics (10) report no increase in mortality or in the number of complications when the common duct is opened routinely, it seems improbable that this record can be equaled in operations on the biliary tract done by surgeons in general, and it would appear that a widespread attempt to follow the lead of these clinics must bring about an increase in the number of complications.

The whole subject of biliary obstruction has been so thoroughly considered by various authors (5, 7, 8, and 15) that little additional remains to be said, even with the added experience of recent years. In this brief discussion only cases of benign stricture, occurring after removal of the gall bladder, will be considered. Among the procedures which have been tried for the relief of such strictures are:

1. Plastic operations on the common duct itself.
2. Excision of the strictured area of the common duct with end-to-end anastomosis, or anastomosis of the proximal end to the duodenum or other portions of the intestine.
3. Anastomosis of the distended common or hepatic duct, without excision, to the: (a) duodenum; (b) stomach; (c) jejunum or ileum; (d) colon.
4. Transplantation to the intestine of fistulous tracts.

Plastic operations on the ducts are not often possible from a technical standpoint; when done they seldom achieve satisfactory results because of recurrent obstruction. Most of the plastic surgery attempted has followed the principle of the Heineke-Mikulicz or Horsley operation on the duodenum.

The last method, like the first, has a limited field of usefulness. It involves the use of a fistulous tract, the result of long continued drainage from the bile ducts through the abdominal wall. This tubular tract, lined with epithelium, has been dissected out and transplanted into the duodenum or stomach. At least a dozen such success-

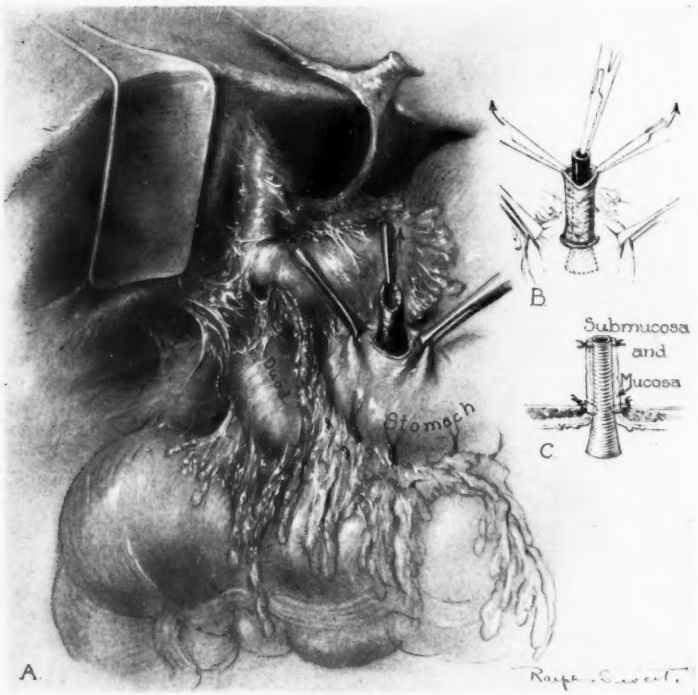

Fig. 1.

ful transplantations have been reported (14). There have been, however, more failures than successful results from this procedure and it has been no more satisfactory than plastic operations on the common duct itself. It should be employed only when other types of anastomosis cannot be done.

The greater number of plastic repairs reported have been accomplished by means of an anastomosis of the common duct to the duodenum. The early work on this subject, particularly that of Mayo, beginning as early as 1905, assumed that anastomosis to the duodenum was essential to good function, as the natural communication is into this part of the gut. For this reason the greatest number of anastomoses since that time have been to the duodenum. These operations have usually been attended by a high percentage of excellent results. Many authors believe, however, that there is less ascending infection and reaction when the anastomosis is made to the stomach than when it is made to the duodenum, and others feel that the results of this procedure are at least equally good.

The experimental work of Oddi and Dostre, more recently confirmed by Beaver and others who have studied the effect of shunting the contents of the biliary tract into the stomach, showed definitely that bile has no effect on the motility, acidity, or emptying time of this organ. These facts have been commented on by various authors, but need to be emphasized again. Almost without exception, however, whether the anastomosis is made to the stomach, duodenum, or other part of the intestine, transient attacks of chills, fever, and jaundice follow (14). Such reactions come from two sources: first, a latent infection which remains in the ducts; second, an ascending infection from the gut which produces a similar chain of events—namely, chills, fever, and jaundice. This reaction is of about the same degree whether the anastomosis is made to the stomach or to the duodenum. If, however, the anastomosis is made farther down the intestinal tract the infection is more serious. Apparently the sphincter of Oddi has a function—the prevention of ascending infections—which we are unable to duplicate surgically.

Since the stomach tolerates the presence of bile as well as does the duodenum, the choice of procedures should depend upon the technical difficulties involved. While the establishment of drainage to the duodenum has been the procedure of choice, if mechanical difficulties are present—particularly the necessity for extensive dissections, the breaking up of adhesions, a lack of natural approximation or other causes—union to the stomach is just as satisfactory and often can be more easily and quickly done. In addition to the simplicity of this procedure, it is well known that the content of the stomach, if leakage should occur, has less digestive action upon the skin and other tissues than the content of the duodenum. Any leakage from the duodenum may be a serious or fatal complication. Often the duodenum is thin and friable while the wall of the stomach is thick, holds sutures better, and insures a better union.

The anastomoses to the stomach have usually been done by the same method of direct suture that has been used in the duodenum. I have developed another type of anastomosis, original as far as I know, which takes advantage of the unusual redundancy and flexibility of the layers formed by the mucosa and submucosa of the wall of the stomach, and which I believe is easier, safer, and more rapid.

TECHNIQUE OF OPERATION[1]

Step I. A small opening is made in that portion of the stomach which best approximates the dilated bile duct. The edges of the mucous membrane are grasped with Allis forceps and drawn out through the opening in the musculature (Fig. 1, *A*). This loose mucous membrane can be withdrawn from 1 to 2½ centimeters beyond the muscular wall. A rubber tube is inserted through this opening in the stomach and the edges of the mucous membrane are sutured to the outer end of the tube. The tube, with the mucous membrane covering it, is then pulled out as far as possible without causing undue tension and then the muscular coat of the stomach is sutured to the base of the tube to maintain the projection (Fig. 1, *B* and *C*).

Step II. A small opening is then made in the distended bile duct and the contents are aspirated or removed by suction. A pursestring suture of catgut is laid around the edge of this opening, going in and out.

Fig. 2.

Step III. Loose catgut sutures, usually three or more in number, attaching the wall of the stomach to the bile ducts or surrounding adhesions, are laid down and clamped (Fig. 2, *A*).

Step IV. The tube, covered with mucous membrane, projecting from the stomach, is thrust into the opening of the bile duct, the posterior approximating sutures are drawn taut and tied, the pursestring suture surrounding the opening in the bile duct is drawn taut and tied around the tube, and the upper approximating sutures, previously laid down, are tied (Fig. 2, *B*).

The result of this procedure is a tube, covered with the mucous membrane from the stomach, projecting well into the bile duct, with mucous membrane approximated to mucous membrane, and with the peritoneum of the stomach well approximated to the peritoneum of the bile duct. The operation can be done rapidly, with a minimum of technical difficulty, and in my experience has been very satisfactory. I do not know how long this tube remains in place—probably only for a few weeks.

REPORT OF CASE OF ANASTOMOSIS OF HEPATIC DUCT TO STOMACH

Mrs. W. A. S., 55 years of age, a housewife, began to have attacks of gall-bladder disease many years ago. A diagnosis of gall stones was made 8 years before operation was performed. On January 6, 1930, the gall bladder was removed elsewhere. Considerable hemorrhage was asso-

[1]Additional items of technique which have been found useful: (1) The stab wound opening in the stomach should not be larger than a Bard-Parker blade No. 10 will make. (2) The flared end of a catheter, No. 18 to 22 French, is an excellent rubber tube for the anastomosis. (3) It is frequently advisable to allow the rubber tube to project about ½ centimeter beyond the free edge of the mucosa to facilitate handling without trauma. (4) A continuous line of peritoneal sutures may be used if the tissues of the bile duct or surrounding adhesions are strong and thick enough to give a good union. (5) The same technique is entirely satisfactory in doing a cholecystogastrostomy.

ciated with the operation. Hernia developed and was repaired in April, 1930, without success. In the latter part of July, 1930, the patient began to have pain in the abdomen and jaundice appeared rather suddenly. The jaundice increased and obstruction of the common duct soon became complete. The obstruction had existed about 7 weeks when the patient was referred to me.

When I saw her on August 28, 1930, the patient had a total obstruction of the common duct, was losing weight at the rate of 1 pound a day, and weighed only 90 pounds. Her condition was desperate.

Operation. The abdomen was opened through the old scar. The omentum and transverse colon were found densely adherent to the liver. As these adhesions were dissected off, the left hepatic duct came to view. It was very large and dilated, and the wall was very thin. In dissecting the adhesions from this dilated duct it spontaneously ruptured and about 400 cubic centimeters of white bile exuded. The common duct could not be identified; it was buried in a mass of adhesions which apparently totally obliterated it. The duodenum was also markedly adherent and was recognized with difficulty. The dilated left hepatic duct lay directly over the pyloric end of the stomach. An anastomosis was made between them by the technique described above. It seemed necessary to repair the hernia because protrusion of the viscera might allow tension upon the anastomosis. This was done by the massive overlap method with interlocking rows of mattress sutures. The patient's recovery was uneventful. The rubber tube was seen in the small intestine 4 weeks after the operation and was passed soon after.

During the first year after operation this patient had 3 attacks of chills, fever, and jaundice, the longest of which lasted 2 weeks. Since that time there have been slight attacks of indigestion from time to time but no other untoward symptoms. The patient is well now, 6 years after operation.

SUMMARY

1. Anastomosis of any part of the occluded bile duct to the stomach gives just as satisfactory function as does anastomosis to the duodenum, and frequently can be more easily and safely done.

2. A new, rapid method of anastomosis of bile duct to the stomach is demonstrated which appears to have certain advantages over the direct suture method.

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HEMITHYROIDECTOMY IN STAGES IN THE TREATMENT OF HYPERTHYROIDISM

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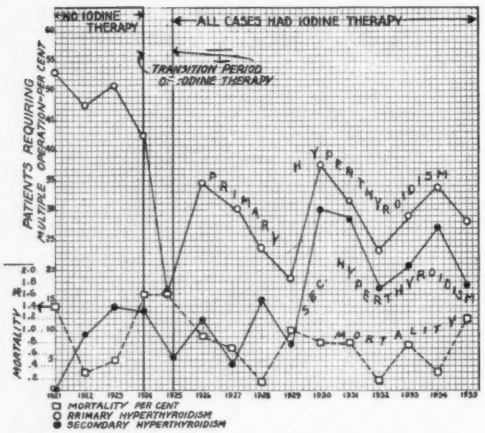
THE employment of stage operations in the severe grades of hyperthyroidism has long been recognized as a valuable method of reducing surgical mortality. Ligation of the superior thyroid vessels is a distinctly useful operative procedure in the surgical management of a small percentage of toxic goiter patients and is still of great value as a preliminary measure in patients with hyperthyroidism who are too ill for even a right hemithyroidectomy. Lahey and Schwalm have recently published a review of a series of 119 patients who had pole ligations performed in this clinic, and their study reveals that approximately 65 per cent of these cases showed improvement in their disease as indicated by a gain in weight, decrease in basal metabolism, and a drop in pulse rate. In other words, a definite marked improvement was noted in a large percentage of these seriously toxic cases, following which a right subtotal hemithyroidectomy could safely be performed. We have thought that it might be of value to carry out a similar study of a group of cases requiring a two stage operative procedure and recording the results obtained following a right subtotal hemithyroidectomy. For this review we have selected a group of 250 consecutive cases of hyperthyroidism, upon whom a two stage right and left hemithyroidectomy was done at intervals of 6 weeks. In this group of 250 cases, there were 149 cases of primary hyperthyroidism and 101 cases of secondary hyperthyroidism occurring in adenomatous goiter, and of this series there were 48 men and 202 women, which is approximately the ratio of hyperthyroidism noted in the two sexes (1:4).

In addition to reporting some of the results obtained by a two stage procedure, we wish to discuss some of the indications for such conservative surgery and also to point out a few of the factors influencing the operative mortality rate. Through the use of iodine and by continuing to employ stage procedure, we have today changed the uncertainty of thyroid surgery to an operative procedure with a large margin of safety. It is difficult to estimate precisely the influence of such factors as age, duration of disease, the severity of hyperthyroidism as evidenced by high basal rate and other more indefinite factors, such as debility and degenerative changes, but experience has taught us that such factors as these must make us in many instances, at least, consider conservative surgery if we hope to avoid an operative fatality.

Any clinic possessing a reputation for handling a large number of thyroid cases will necessarily attract a great many serious goiter patients. A large majority of these patients will represent very definite increased operative risks by virtue of their thyroid intoxication, and while many of these patients present problems pertaining only to a severe grade of hyperthyroidism, other patients will fall into this high risk group because of the additional technical difficulties encountered at operation in such patients. We refer specifically to the group of large intrathoracic goiters with hyperthyroidism exhibiting evidence of trachial compression or deviation. Because of this reputation of a large experience in thyroid surgery, the surgeon's obligation to these patients is increased manifold.

In order to manage this group of increased risks we must outline definite criteria which will enable us to estimate more correctly the operative hazard and to predict more accurately a safe outcome. Much more important than the mere recognition of the increased risk, we must plan a type of procedure that we know, from experience, will most certainly increase the patient's chances of surviving the operation. The demand in these bad risks is for a safe operative procedure. It is our plain duty to patients in this high risk group to meet this obligation, and this is best met by conservative operative measures. It is true that the introduction of iodine by Plummer has had a far reaching effect upon the treatment of diseases of the thyroid gland and the contrast between the present treatment and that before iodine was employed is tremendous. Where in the past numerous articles emphasized the necessity of stage operations to prevent fatalities, more recent papers have called attention to the pronounced effect obtained by the administration of iodine upon the course of the disease and upon the pathological changes in the thyroid gland. Recently the impression has grown widespread that stage operations are no longer needed in the treatment of severe hyperthyroidism and that if the patient is prepared properly before operation, if the operation is performed without technical mishaps and within a reasonable time, the patient will easily


NO IODINE THERAPY
ALL CASES HAD IODINE THERAPY
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PATIENTS REQUIRING MULTIPLE OPERATIONS PER CENT
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1921 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935
MORTALITY PER CENT
PRIMARY HYPERTHYROIDISM
SECONDARY HYPERTHYROIDISM

Fig. 1. The percentage of cases of primary and secondary hyperthyroidism requiring two or more operations. For the last 6 years, the two curves exactly parallel each other and more nearly approach. Note change in number of multiple operations with use of iodine after 1925. The mortality rate is also recorded. Note that in most instances the mortality rate rises with decrease in the number of multiple operations as in 1925, 1929, and 1935, whereas in 1926, 1930, and 1934 the mortality rate decreases with more stage operations.

withstand a complete subtotal thyroidectomy. Based upon our experience, nothing is farther from the truth and if this opinion is persisted in, it will undoubtedly result in many unnecessary operative deaths.

Fig. 2. Severe primary hyperthyroidism—basal metabolic rate +3, pulse 76 upon admission to hospital; 44 years of age, with loss of 56 pounds over a period of 2 years; note marked exophthalmos; photograph made 5 days following right hemithyroidectomy, first stage. Course during operation confirmed clinical impression of intense degree of toxicity.

Prior to the development of the use of iodine in the preparation of toxic thyroid patients for surgery, stage operations were performed in many instances in the more intensely toxic cases. A large majority of these patients required two or more stages, and we have all had the experience of doing as many as five or six stages in the more

Fig. 3. A case of apathetic hyperthyroidism. Note the wrinkled skin, the extreme weight loss, the lack of eye signs, lack of activation, lack of thyroid enlargement, and the suggestion of apathy. Note also the senile appearance although this patient was 49 years of age. Basal metabolic rate was +21, pulse 104. A two stage operation was done with a weight gain of 8 pounds in 6 weeks between stages. Excellent recovery.

Fig. 4. A, left, Severe primary hyperthyroidism in child of 10; note stare, enlarged thyroid, evidence of weight loss. Basal metabolic rate was +68, pulse 120; B, same child 6 weeks after right hemithyroidectomy and 3 days after left hemithyroidectomy, second stage. Note absence of stare, gain in weight of 20 pounds. Pulse was 88; basal metabolic rate +3 at time of second admission to hospital; marked improvement in 6 weeks.

seriously ill, hyperthyroid individual. From January, 1925, to the present time all patients with hyperthyroidism in this clinic have received iodine in preparation for surgery, and it is of interest to note that over a period of 11 years, from January, 1925, to January, 1936, no toxic thyroid patient has required more than three operations—that is, a preliminary bilateral pole ligation followed by a right and left hemithyroidectomy at intervals of 6 weeks. Prior to this period in many cases four and five stage operations and occasionally six operations were necessary to prevent operative fatalities and safely to terminate the disease.

Table I illustrates the number of stage procedures performed over a period of 4 years from 1921 to 1924 before iodine was used and shows the relatively large number of cases in which three or more stages were necessary.

Prior to this period the surgeon feared the development of serious postoperative reactions. These reactions were very frequent, were often difficult to handle and not uncommonly resulted in a fatality; consequently, during this period conservative surgery was quite universally advocated and practiced in clinics having a considerable experience with thyroid disease. The employment of iodine before operation has resulted in great improvement in the handling of these cases and has been extremely valuable as a means of treatment following operation. The period of pre-operative management has been decreased, the technical difficulties previously noted during operation have been lessened, because of earlier and more complete involution of the gland, and a smoother convalescence has resulted. We have noted, moreover, a decrease in the number of preliminary pole ligations and of stage operations and, finally, a decrease in the operative mortality.

While we believe that the employment of iodine has accomplished a material advance in the treatment of hyperthyroidism, we still feel, nevertheless, that there is a very definite need for stage procedures in the intensely intoxicated thyroid patient if we are to keep the mortality rate at a minimum. It has been our experience, and we are firmly convinced from a study of our large series of thyroid operations, that the operative mortality rate in this high risk group is definitely proportional to the number of stage operative procedures performed. It has also been our experience that while there has been a material decrease in the number of patients requiring stage operations, we have noted a greater decrease in the number of operations required per person. Dr. F. H. Lahey has repeatedly emphasized that

TABLE I.—STAGES NECESSARY—1921 TO 1924

	2 stages per cent	3 stages per cent	4 stages per cent	5 stages per cent	6 stages per cent
1921	35	12.5	5.4	0	0
1922	27	14.3	5.5	0.8	0
1923	34	10.6	4.7	0.6	0.6
1924	30	11.7	4.0	1.3	0

when a patient dies following a subtotal thyroidectomy that patient would probably have survived if a right hemithyroidectomy had been done; that if death ensues after a right hemithyroidectomy, a bilateral superior pole ligation should have been done as a preliminary measure. That a low mortality rate can be obtained by conservative measures is illustrated by the fact that frequently one can operate upon a large group of cases without a single fatality; in 1932 we performed 1021 consecutive thyroid operations with but 1 death. In this clinic we have now (October 1, 1936) performed 15,214 thyroid operations with 111 postoperative deaths, a mortality rate for the series of 0.73 per cent. All deaths occurring from emboli, cardiac failure, pulmonary complications and from operations for cancer of the thyroid are included in this group. During this same period there were 60 deaths in patients so seriously ill with hyperthyroidism when entering the hospital that we were unable to prepare and bring them to operation although every known measure to combat thyroid crisis was employed.

In spite of the great benefit derived from employing iodine in the pre-operative management of patients with hyperthyroidism, we are continuing to use stage operations in a considerable percentage of our toxic patients and in our hands the utilization of stage procedures has been one of the most valuable means of preventing operative fatalities. As stated above, there has been a marked decrease in the number of pole ligations done since iodine has been in use. Over a period of 10 years, from 1926 through 1935, we have done preliminary superior pole ligations in 1.2 per cent of our cases of hyperthyroidism.

During 1924 we performed 57 pole ligations, whereas in the 11 years following only 67 ligations were done. A somewhat similar decrease has been noted in the number of patients requiring multiple stage operations, as in 1921, one of the pre-iodine years, 47 per cent of all the cases of hyperthyroidism required multiple operations, whereas in 1929, with the employment of iodine in preparation for operation, only 16 per cent had operations in stages. The percentage of patients requiring stage procedures has, of course, varied

TABLE II.—HYPERTHYROIDISM REQUIRING MULTIPLE STAGE OPERATIONS

Type of hyperthyroidism	Multiple operations per cent	Operative mortality per cent
Primary	28.9	0.48
Secondary	17.8	1.55

from year to year, yet there has regularly been a quite definite decrease. Over a period of 10 years from January, 1926, to January, 1936, 28.9 per cent of our cases of primary hyperthyroidism had stage operations with an operative mortality of 0.48 per cent.

During this same period 17.8 per cent of our adenomatous goiters with secondary hyperthyroidism were operated upon in multiple stages with an operative mortality of 1.55 per cent. Table II illustrates the percentage of cases of primary and secondary hyperthyroidism requiring multiple stage operations over a period from 1921 to January, 1936. It will be of interest to note that less stage procedures were performed upon adenomatous goiter than upon primary hyperthyroidism, yet secondary hyperthyroidism in adenomatous goiter carries with it a greater operative hazard. The mortality rate for adenomatous goiter with secondary hyperthyroidism has always been higher than the rate for primary hyperthyroidism and for the period here recorded it has been three times as high.

Next to the employment of stage procedures in reducing operative mortality has been the development of an organization of co-operative management of patients with hyperthyroidism whereby during their entire period of hospitalization they are under the constant supervision of both the surgeon and the internist. This medical and surgical integration makes for a more accurate estimation of the operative risk, a more efficient preparation of the patient for surgery; postoperative complications can be handled more intelligently, and certainly the complications can be recognized earlier and adequate treatment instituted sooner. Dr. Lahey repeatedly has emphasized the serious emergency situations which will occasionally arise following thyroid surgery, and every member of the staff, whether surgical or medical, must be aware of the possible character of these mishaps and be prepared to anticipate or meet them should they arise.

As a measure of general precaution, every patient with thyroid disease examined in this clinic has an estimate of the operative risk made by each examiner. We have made use of a more or less arbitrary scale by which we have indicated the risk as follows: Grade I being a good risk; grade II, a doubtful risk; grade III, a dangerous risk; grade IV, a risk in which a fatality will almost certainly result if operation is performed. In addition, after a few days' preparation in the hospital, we ask each examiner to estimate the extent of the operative procedure that the patient can probably withstand without a fatality ensuing and to record such an opinion on the patient's record. It is our custom to utilize constantly the experience and advice of our anesthetists. The anesthetist will, in every instance, see each patient the day before the patient comes to the operating room. He will examine the patient and review the case record and will in every instance record his opinion of the operative risk. If the surgeon ignores the warnings, if so recorded, and does not choose a conservative procedure and a fatality occurs, the responsibility is so plainly his that he will probably never do it again. Probably a few more stage operations than are necessary will be done by this plan, but this, we feel, will be but a minor consideration if but a single life be saved. We have always taken the consistent stand that if there is any question of doubt as to the amount of surgery that a patient can withstand, we must by all means choose the more conservative measure. No excuse can be acceptable in the face of such warnings if a fatality results. We must not adopt a complacent and fatalistic attitude toward any such death. Experience, it is true, can and does provide the background by which deaths may be avoided, but death, in spite of experience, must not be the excuse with which casually to explain an unexpected death. We must profit by the lesson which a critical review of the case history of every thyroid death brings to us and too frequently we must frankly admit that no explanation is forthcoming other than that too much surgery has been done and bad judgment employed.

It is obvious that the determination of the operability of patients with severe hyperthyroidism is to a great degree dependent upon a large experience with thyroid surgery, but it is also to a considerable extent dependent upon other factors, such as age, duration of disease, severity of the intoxication, weight loss, and such factors. While it may be true that we cannot sharply separate by age, by height of basal metabolism, by weight loss, etc., the severe cases which require stage procedures from the less toxic cases which will not, yet we know from long observation that a careful evaluation of all these combined factors will usually indicate that the hyperthyroidism is of such a degree of severity

TABLE III.—AGE INCIDENCE—250 CASES WITH OPERATION IN TWO STAGES

Between ages years	Cases of primary hyperthyroidism	Cases of secondary hyperthyroidism	Total per cent
10–20	5	1	2.4
21–30	13	0	5.2
31–40	30	10	16.0
41–50	45	19	25.6
51–60	34	40	29.6
61 and over	22	31	21.2
	149	101	100.0

Youngest patient with primary hyperthyroidism 7 years; oldest 72 years.
Youngest patient with secondary hyperthyroidism 12 years; oldest 78 years.

TABLE IV.—DURATION OF DISEASE—250 CASES—TWO STAGES

Duration	Cases of primary hyperthyroidism	Cases of secondary hyperthyroidism	Total per cent
1 to 6 months	35	22	22.8
7 to 12 months	34	16	20.0
1 to 2 years	56	38	37.6
2 to 5 years	20	12	12.8
5 years plus	4	13	6.8
	149	101	100.0

that a fatality will almost certainly result if a complete subtotal thyroidectomy be done.

The age of the patient has always been of value in estimating the operative hazard in any type of surgery and this is particularly true in surgery of the thyroid gland. Elderly patients are conceded to be poor operative risks, and, when severe thyroid intoxication is present in this older group, our choice of stage procedures must be frequently influenced by this fact. The so called reserve of a younger individual has definitely decreased in patients past middle age and the capacity to withstand the added insult of operation in addition to the changes brought about by the hyperthyroidism is much lessened. In people of advanced years we are dealing with a high risk group, and the possibility of two or more stage operative procedures must be considered in this group. It is of interest to note that of 93 deaths of the total of 111 postoperative thyroid deaths in the history of the clinic, there were 73 patients who were 41 years of age or over. It is also noted in the group of 250 cases of hyperthyroidism in this series that 76 per cent were 41 years of age or over (Table III). We have also called attention to the fact that patients with secondary hyperthyroidism are usually older than those with primary hyperthyroidism. In this series, 38 per cent of the patients with primary hyperthyroidism are over 51 years of age, whereas 70 per cent with secondary hyperthyroidism are 51 years or older.

The duration of the hyperthyroidism undoubtedly has had a definite influence upon the mortality rate. It has been our experience that patients who have had the disease for a period of a year or more have a higher mortality rate than those ill for less than a year. Approximately 85 per cent of the 93 deaths referred to had had hyperthyroidism for a year or more. One cannot evade the conviction that long continued thyroid intoxication produces undesirable changes in the body. In the earlier stages of the disease we have to deal only with the severity of the hyperthyroidism, whereas later we have, in addition, to cope with these organic changes. We know that in patients with prolonged and severe hyperthyroidism liver function is materially interfered with and it is not at all uncommon even to see jaundice in the severely intoxicated thyroid patient. Major cardiac disability is frequently encountered as a result of an overactive, irregular heart and increased circulatory demands upon the heart over long periods of time. (Table IV.)

In the patients studied in this series, 143, or 57 per cent, had the disease over a year, whereas 77 per cent had the disease over 6 months. There is no doubt that the longer patients have had hyperthyroidism, the more serious is the operative hazard, and it is in this group that we must frequently choose the more conservative procedures if we wish to avoid operative deaths.

Weight loss, which may even be excessive, is a common finding in patients with severe hyperthyroidism. We have seen tremendous emaciation and debilitation resulting from an intense degree of toxicity and we have seen these patients lose weight in spite of an intake of food far beyond their normal need and capacity. Due to this intense intoxication resulting from an abnormally overactive thyroid, there is an actual consumption of the patient's tissues not compensated for even by a vastly increased food intake. These patients will frequently progress into a state of thyroid crisis if the process is allowed to continue uncombated, and many of the patients in this group must be candidates for stage operations if we are to avoid operative fatalities. (Table V.)

We regard marked weight loss to be a definite indication of operative hazard, and in this series

TABLE V.—WEIGHT LOSS PRIOR TO ADMISSION TO HOSPITAL—250 CASES—TWO STAGES

Pounds	Cases of primary hyperthyroidism	Cases of secondary hyperthyroidism	Total per cent
Indefinite	13	20	13.2
1 to 10	24	10	13.6
11 to 20	37	20	22.8
21 to 30	27	18	18.0
31 to 40	23	14	14.8
41 to 50	10	8	7.2
51 plus	15	11	10.4
	149	101	100.0

Greatest weight loss—84 pounds.

TABLE VI.—BASAL METABOLIC RATE—250 CASES—TWO STAGES

Metabolic rate	Cases of primary hyperthyroidism	Cases of secondary hyperthyroidism	Total per cent
Not recorded	0	1	0.4
Plus 10 to plus 30	16	22	15.2
Plus 30 to plus 50	44	45	35.6
Plus 50 to plus 70	60	24	33.6
70 plus	29	9	15.2
	149	101	100.0

we find that 73 per cent have lost 10 pounds or more and that 10 per cent have lost 50 pounds or more. Frequently we see patients who have lost more weight than their actual body weight recorded upon admission to the hospital. The greatest weight loss in this group was 84 pounds.

Basal metabolic rates, when high, are approximate measures of the intensity of the toxic process but are not reliable indices for estimating the degrees of operative risk. While a high rate usually accompanies severe hyperthyroidism, a low rate does not necessarily mean a milder degree of toxicity and certainly is no indication of the patient's ability to withstand the intoxication or operation. Of the 250 patients in this series, there were 38 patients whose initial basal metabolic rate was plus 30 or less and yet, because of other symptoms noted, we regarded these cases to be in such a high risk group that we considered that they should have a two stage procedure. We have all seen patients with a normal or relatively low basal metabolic rate who may even have a pulse rate of 80 to 90 and yet who are markedly activated, whose hands are hot and moist, and who have lost great amounts of weight (Fig. 2). We must measure the degree of intoxication by many factors and one's judgment as to the degree of risk is often substantiated by the patient's course while undergoing the operation. Basal metabolic rates are ordinarily higher in primary, than in secondary, hyperthyroidism and in this group 60 per cent of those with primary hyperthyroidism had a metabolism above plus 50, whereas only 33 per cent of the toxic adenomas had a metabolism of plus 50 or above. (Table VI.)

Three patients were noted with basal metabolic rates of plus 110, plus 119, and plus 123, respectively, and these were cases of primary hyperthyroidism.

Thyrocardiacs present an increased operative hazard whenever subjected to an operation. In this clinic the term thyrocardiac has been employed to describe patients with hyperthyroidism in whom major cardiac disability has been a prominent feature. Dr. L. M. Hurxthal of the medical department of the clinic, in studies of this group has found that in approximately 10 per cent of all toxic thyroid cases auricular fibrillation is present, either transient or established, and that in 4 per cent congestive heart failure is noted. In this series of 250 cases, 35 per cent of the patients had evidence of cardiac disability such as auricular fibrillation, gallop rhythm, congestive heart failure, or other cardiac disability. In 55, or 22 per cent, auricular fibrillation was noted upon admission to the hospital. Following a right hemithyroidectomy and upon returning to the hospital for a left hemithyroidectomy after the usual 6 week period, 21 of the 55 had established a regular rhythm, while 34 had continued to show fibrillation. The cardiac reserve is decreased in this group of patients and with the burden of hyperthyroidism added, operation very often carries with it such an increase in risk that a more conservative measure than complete subtotal thyroidectomy must frequently be chosen if we wish to avoid a mortality.

Toxic adenomatous goiter when subjected to surgery possesses a higher mortality rate than primary hyperthyroidism. As stated, the mortality rate for toxic adenomatous goiter over a period of 10 years has been approximately three times higher than that for primary hyperthyroidism. Several factors probably influence this higher rate; notably the duration of the disease has in many instances been longer and many of the patients are in the older age group—that is, past middle age. Possibly the lower percentage of stage operations in this group has affected the mortality rate; as previously pointed out, over a 10 year period from 1926 to January, 1936, only

17 per cent had stage procedures whereas 28 per cent of the cases of primary hyperthyroidism had stage operations. Elderly patients with toxic adenomas frequently show surprisingly few clinical signs of severe toxicity and yet prove to be most serious operative risks.

Apathetic hyperthyroidism has been described from time to time by Dr. F. H. Lahey and the high risks attendant upon operation in these cases have been repeatedly emphasized by him. Apathetic hyperthyroidism (Fig. 3) in contradistinction to the usual activating type is characterized by apathy rather than activation. The gland is relatively small and firm and there is an associated low basal metabolic rate, frequently not more than plus 30. The pulse rate may run around 100 to 110 and these patients are usually past middle age. The skin is not hot and flushed as in activating type but on the contrary is cool, pigmented, and wrinkled. Because of the apparent mildness of the intoxication, one is tempted to proceed with a complete subtotal thyroidectomy and if done a fatality will almost certainly result. It is essential that a two stage procedure be planned for these apathetic cases if we wish to avoid a fatality and, while they are not frequent, it is necessary that they be recognized. We have had 8 cases of apathetic hyperthyroidism in this series of 250 cases.

Attention has been called frequently to the seriousness of acute infection complicating hyperthyroidism. Any active infection, such as appendicitis, pyelitis, or acute streptococcic infection of the throat, may convert a moderately severe case of hyperthyroidism into a serious risk by suddenly intensifying the intoxication. A state of thyroid crisis may result and a fatality occur before surgery can be done. Operation must be postponed indefinitely in these cases and when undertaken must not infrequently be done in stage procedures to avoid a fatal outcome. In this group of 250 patients there have been 3 cases of acute hyperthyroidism in children less than 10 years of age. We believe that a two stage procedure must be performed in a large percentage of cases of hyperthyroidism occurring in children, because of the tendency of children to have rather serious reactions after operation. Diabetic patients developing hyperthyroidism carry an increased mortality rate with operation. In a study of the cases with this disease combination in this clinic a mortality of 4.8 per cent was reported in an earlier series of 63 patients. By the employment of 100 per cent more stage operations than in the first series in this group of diabetic patients, the mortality in the second series has been notably decreased. In the later series of 56 patients, a mortality rate of 1.6 per cent was noted.

One of the most valuable means of estimating the extent of operative procedure that can be safely performed in severe hyperthyroidism is the response to pre-operative treatment in the hospital. In this clinic the preparation of the patient for surgery consists of a high caloric diet, iodine in the form of Lugol's solution, 10 drops three times a day, and adequate rest in bed. In certain cases the employment of sedatives is also a necessity. After the fourth day we do not confine our patients continuously to bed. They are allowed to be up and about for a part of each day. It is our experience that continuous bed rest is weakening and patients are made more fit subjects for pulmonary complications and for vascular accidents. The period of time needed for this preparation is dependent upon the course of the individual; most cases of hyperthyroidism require from 8 to 12 days; in others, the number of days necessary for pre-operative care is indefinite and will depend upon the patient's progress. Patients who continue to lose weight in the hospital, whose pulse rate remains at high levels, are poor candidates for subtotal thyroidectomy. We believe that in such cases operation must be deferred until definite improvement is noted or until such a time has demonstrated that further improvement cannot be expected until surgery is carried out. We must consider these patients who show little or no improvement during the period of pre-operative preparation to present definitely increased hazards and must plan our operation accordingly in stages, if a fatality is to be avoided.

From an analysis of the factors outlined one can estimate fairly accurately the amount of surgery which a patient can withstand without a fatality resulting; however, it happens not infrequently that one must reserve his estimate of the risk and finally make such a decision at the operating table. At this time we are aided materially by the experience of our anesthetists. They very frequently call our attention to certain reactions of the anesthetized patient, which assist them materially in estimating the intensity of the hyperthyroidism and indicate the necessity for more conservative measures. A steadily rising pulse rate to above 150 or 160 after the period of anesthesia induction is completed, should furnish a warning of a possible postoperative death if a complete subtotal thyroidectomy is persisted in. A rise of blood pressure with an increase of pulse pressure is likewise of great importance in indicating increased operative risk. The necessity for employing large amounts of gas oxygen mixture

during the operation is a very positive sign of intense intoxication. Our anesthetists point out that the moderately toxic thyroid patient will require from 200 to 400 cubic centimeters of oxygen per minute, whereas the high risk patient will use 600 to 800 cubic centimeters of oxygen per minute and, in the face of these warnings, stage procedures must be employed to avoid fatalities.

From a review of this series of 250 patients upon whom a two stage procedure was carried out, it has been our desire not only to emphasize the significance of certain factors which we believe should make us consider stage operations, but we have also been interested in the results obtained following a right hemithyroidectomy. We are presumably dealing with a more serious group of thyroid patients, and we wished to know if improvement could be obtained in a sufficiently large percentage to justify having the patient submit to two operations and also to justify the increased economic loss to the patient. We can positively state from our experience that the mortality rate can be lowered to an absolute minimum by the employment of stage operations and in our hands this has been the most important single factor in increasing the margin of safety for the patient intensely ill with hyperthyroidism.

It is significant that in this group of selected high risk cases there was not a single death following a right hemithyroidectomy nor did any fatality result from the second stage procedure which was performed 6 weeks later. As one would expect there was a small percentage of patients in this series who failed to show improvement, yet at the same time no patient progressed so far in the disease that he presented appreciably more risk upon his return to the hospital for his second operation than he showed when he came for the first stage. Almost without exception, convalescence was uneventful following a left hemithyroidectomy, which was the second and final stage, and in no instance was there any postoperative reaction which in any way approached a state of crisis. Our study clearly shows that these patients were singularly free of any serious reactions following the second stage operation and we have learned to expect a smoother convalescence in our second stage cases than in the first stage cases. One can be reasonably certain, aside from unpredictable complications, such as embolism or pneumonia, that death will not result from the second stage procedure since these patients have survived a more serious risk operation and are, for the most part, in greatly improved condition.

Following convalescence from a right hemithyroidectomy, these patients are discharged to their homes for a period of 6 weeks. During this period they are directed to take iodine in the form of Lugol's solution, 10 drops once daily, and are also asked to follow a definite schedule of rest. It is of interest to note that of this group not a single patient failed to return for the second stage of the operation. In our entire series of thyroid operations we have had only 2 patients who failed to return for the final stage of the operation. Almost without exception these patients are appreciative of one's efforts to guard them against a fatality and such marked improvement was appreciated in a large majority of the cases that we have had no trouble in getting the patient to submit to the second operation.

From past experience we have arbitrarily fixed upon an interval of 6 weeks between stages. We have found that the edema and the exudative infiltration in the wound is entirely absent after that period and that reopening of the neck then is a much simpler technical procedure than if it were carried out at an earlier date. Also, during this interval the patient has had sufficient time to show all of the improvement obtainable from the first stage.

In a large percentage of these cases the improvement may be quite startling. Many of the clinical manifestations of hyperthyroidism may be absent upon their second admission to the hospital; activation may be lacking and the stare gone (Fig. 4). One can expect a gain in weight. Pulse rate in most cases will have decreased and in many instances will have resumed a normal rate. Basal metabolic rate will have diminished and not infrequently have become entirely normal. Patients exhibiting mental changes from the intensity of the hyperthyroidism will show a remarkable improvement in their mental state. One frequently sees patients who to all intents and purposes have completely recovered—that is, the pulse is normal, the basal rate has reached a normal level and all clinical manifestations are absent. We should, however, in these cases proceed with the left subtotal hemithyroidectomy because one can usually predict a recurrence of symptoms, often equally as severe as noted upon first admission if the second stage operation is unduly delayed. While we have no figures to substantiate a recrudescence of the disease to a state of its former intensity, a patient will, occasionally, be delayed beyond the usual 6 weeks interval and, upon returning for the second stage, symptoms will be evident which indicate a gradually renewed activity of the intoxication.

Patients frequently will show a remarkable gain in weight between stages, the greatest gain

being 30 pounds in 6 weeks. Table VII shows the percentage of cases exhibiting improvement in weight between stages.

TABLE VII.—CHANGES IN WEIGHT BETWEEN FIRST AND SECOND STAGES HEMITHYROIDECTOMY—250 CASES

	Primary hyperthyroidism 149 cases per cent	Secondary hyperthyroidism 101 cases per cent	Total 2 stages per cent
Gain in weight	86.5	75	82
Loss in weight	11.4	20	14.8
No change	2.1	5	3.2

We have found that 82 per cent of this group showed a gain in weight of 1 to 30 pounds. It is also of interest to note that many of the patients who failed to reveal improvement in weight showed a drop in pulse rate and in basal metabolic rate. It is also of interest to note that patients with secondary hyperthyroidism exhibited a slightly decreased tendency to gain weight than did patients having primary hyperthyroidism. In this series 75 per cent of toxic adenoma patients gained weight in contrast to weight gained in 86.5 per cent of the cases of primary hyperthyroidism.

There was also noted improvement in pulse rate in 73.2 per cent of the total series. In 60 cases, or 24 per cent, of the total series, the pulse rate decreased to a normal level.

TABLE VIII.—PULSE RATE CHANGE BETWEEN FIRST AND SECOND STAGE HEMITHYROIDECTOMY—250 CASES

	Primary hyperthyroidism 149 cases per cent	Secondary hyperthyroidism 101 cases per cent	Total 2 stages per cent
Pulse rate drop	80	64	73.2
Pulse rate unchanged	19	32	24.4
Pulse rate increased	1	4	2.4

We have found that secondary hyperthyroidism is less apt to show improvement in pulse rate than is primary hyperthyroidism. This same difference toward improvement of pulse rate in this group was noted in respect to weight gain.

Our study revealed also that we could expect a decrease in the severity of the hyperthyroidism as indicated by decrease in the basal metabolic rate—84.8 per cent of the 250 cases showed a definite drop in basal metabolism. We note here also a similar tendency to lack of improvement between stages in secondary hyperthyroidism patients as compared to the primary hyperthyroidism patients. Table IX gives figures for basal metabolism changes in both types of cases. In 45 patients the metabolic rate reached the range of normal.

TABLE IX.—BASAL METABOLISM CHANGE BETWEEN FIRST AND SECOND STAGE HEMITHYROIDECTOMY—250 CASES

	Primary hyperthyroidism per cent	Secondary hyperthyroidism per cent	Total 2 stages per cent
Drop in metabolism	90.7	76	84.8
Unchanged	8.0	21.0	13.2
Increased	1.3	3.0	2.0

From a review of this group of 250 cases, we find that, while we can expect improvement in pulse, weight and metabolic rate in a majority of cases of primary hyperthyroidism following right hemithyroidectomy, we find also that secondary hyperthyroidism is apt to respond less favorably in as large a percentage of cases. This is in accordance with our experience that toxic adenomas present an increased operative hazard and operation carries with it a higher mortality rate than does primary hyperthyroidism.

SUMMARY AND CONCLUSIONS

1. Stage operations, such as a two stage right and left hemithyroidectomy at intervals of 6 weeks are still of great value in the surgical management of patients with severe hyperthyroidism.

2. The mortality rate in toxic goiter is proportional to the percentage of stage operations performed.

3. Factors which affect the mortality rate are outlined and an attempt has been made to indicate the influence of these factors upon the operative risk.

4. Figures are given illustrating the improvement or the lack of improvement following a first stage right hemithyroidectomy.

OLD UNUNITED CLAVICULAR FRACTURES IN THE ADULT

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THE literature on fractures of the clavicle and personal clinical experience give the impression that in the treatment of these fractures the profession is very indifferent; it is assumed that this type of fracture will always unite with a good enough result.

The angulation or deformity, which occurs more frequently than is apparently admitted and which is the result of vicious union or exuberant callus, is accepted as of little consequence.

Many authorities, even though there has been reported a goodly number of cases of vascular and nerve injuries, which may and do occur not only in comminuted but even in simple fractures, either ignore their possibility and importance or consider the possibility of such occurrence as negligible. In a general way I believe that the present day treatment of clavicular fractures, particularly in adults, leaves a good deal to be desired. I am confident of this, because within a comparatively short period I have observed personally 9 cases of ununited clavicular fractures of long standing in adults. Of these cases 6 had brachial plexus involvement and 7 had to be subjected to open surgical treatment and correction owing to the disability to the patients. Recently one case of fracture of the clavicle with malunion and severe brachial plexus involvement was seen and operative correction was advised. With the ever increasing number of automobile accidents, injury to the clavicle in the adult is becoming much more frequent and the nature of the injury is such as to favor non-union or vicious union. Immediate surgical intervention appears to be indicated in many of these cases especially if there is marked displacement of the fragments, which cannot be alined and maintained by the usual conservative treatment of reduction and bandaging.

Among the few opinions expressed on this subject in the literature, is that of Chalier, who remarks that, in some cases, which were neglected at the initial treatment, poor function resulted; hence immediate operative treatment should be applied more often.

Verbrugge states that it is a mistake to consider clavicular fractures as of little consequence because their complications are numerous and may be late, the most serious among these being compression of the brachial plexus, which is frequent—especially in comminuted fractures.

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THE CLAVICLE AND ITS CONNECTIONS

The clavicle is a key bone, which by its articulations with the sternum and acromial process of the scapula binds the upper limb to the skeletal trunk—it being the only bony connection between the arm and trunk. It serves to sustain the upper extremity in the various positions it assumes and also as a fulcrum to enable the associated muscles to allow lateral motions of great latitude to the arm. When the continuity of the bone is disturbed, all these functions in the arm suffer. Yet with vicious overriding, malunion, or callus formation, if not too exuberant, the function of the arm is often surprisingly good.

Children, as a general rule, can in time adapt themselves to a viciously united clavicle. Excess of callus often is absorbed, and the evolution by bone growth corrects angulation at the site of fracture.

Nature has strengthened every part of the bone except at the outer part of the middle one-third, i.e., at the junction of the two curvatures of the bone. This is the thinnest part of the bone. It is not reinforced by ligaments or muscles and in most cases it is the site where traumatic fracture especially of the indirect type occurs.

The relations of the clavicle with the vessels and nerves in its vicinity are important in the case of fractures when injuries to these structures may occur. These relations are shown in the accompanying schematic drawings (Fig. 1, A and B).

The brachial plexus, where it crosses beneath the clavicle, comprises 3 main branches. Of these, two are anterior. One, external, originates from the fifth, sixth, and seventh cervical roots, and forms the musculocutaneous and the external branch of the median nerves, the other internal, originates from the eighth cervical and first dorsal roots and forms the internal branch of the median, the ulnar, and the internal cutaneous nerves. The posterior branch of the plexus forms the circumflex and radial nerves.

The frequency of injury to the brachial plexus and especially of ulnar nerve involvement in the author's series of 9 cases of fracture of the clavicle with non-union and one case with malunion, led

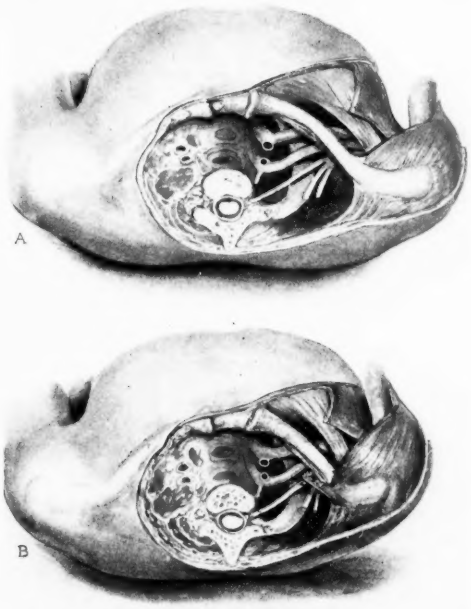

Fig. 1. A, The costoclavicular space and the important structures traversing it as seen from above and posteriorly. B, The costoclavicular space and the important structures traversing it as seen from above and posteriorly. The clavicle has been fractured at the usual site and the shoulder displaced inward, forward and downward. This shows the characteristic narrowing of the "costoclavicular space."

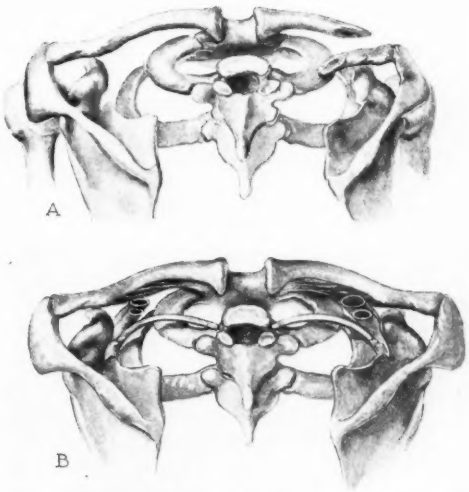

Fig. 2. A, The skeletal relationships of the outer fragment of the fractured clavicle. B, Diagrammatic sketch which attempts to show the increased diameter of the structures traversing the costoclavicular space in the living, on the right side, as compared to the structures in the cadaver on the left. This demonstrates the relatively greater amount of space usually found in the cadaver. Conclusions as to the adequacy of this space cannot be drawn from a study of this space only in the cadaver.

to a careful anatomical investigation of the relationship of the various structures involved.

It was noted in the cadaver that the cord of the brachial plexus, which contains the components of the ulnar nerve, crosses the first rib directly under the middle third of the clavicle, while the other two cords are placed further to the lateral side and posteriorly. Hence, because of their position, they are less liable to injury. It was also noted that the space between the clavicle and first rib is more than adequate to accommodate the structures passing through it (Fig. 1, A).

This space between the clavicle and the first rib will be referred to by the author as the "costoclavicular space." It is bounded below by the first and second ribs, the intercostal, serratus magnus, and subscapularis muscles. The lateral apex is at the angle made by the line of the upper border of the pectoralis minor and that of the clavicle at the coracoid process. The base is toward the sternum at the line of fusion of the costocoracoid membrane with the deep fascia over the upper intercostal spaces. The under surface of the clavicle and subclavius muscle form the anterior and superior boundary of this space.

On careful dissection during operative intervention on the clavicle, the author has repeatedly noticed that this space is not as large in the living subject as it is in the cadaver. The explanation for this may be found in the fact that here the vessels are distended and that the dimensions of the cords of the brachial plexus are several times larger than they are in the cadaver (Fig. 2, B). Also this space is diminished by the elevation of the first rib by the scalenus anticus in the living. Hence, when the inner end of the outer fragment of a fractured clavicle is depressed, there is much less space between the first rib and the clavicle, with the result that the vessels and the nerves, especially the ulnar, are more liable to be subjected to pressure or irritation (Fig. 1, B).

OCCURRENCE

Previous to the summer of 1933 the author was of the opinion that fractures of the clavicle resulted in bony union except in the rarest of

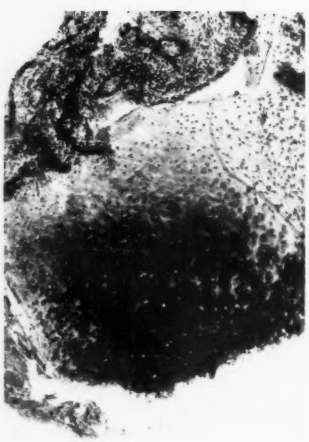

Fig. 3.

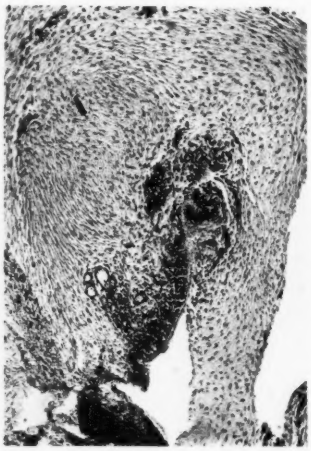

Fig. 4.

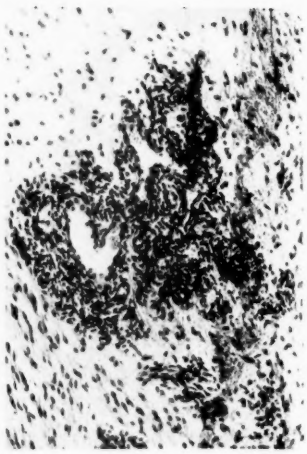

Fig. 5.

Fig. 3. Well formed mature cartilage adjoining synovial cells.

Fig. 4. False joint showing cleft lined with synovial cells. Underneath the synovial cells are to be found capillaries which are lined with swollen endothelial cells.

Fig. 5. Small blood vessels with swollen endothelial cells. The perivascular fibroblasts show the presence of proliferation.

instances. From the scarcity of reported cases of old fractures of the clavicle with non-union in adults in the contemporary literature, he was probably not unjustly holding an erroneous opinion in regard to the incidence of this complication. After having seen 5 such cases in the summer of 1933, this problem was discussed with several eminent orthopedic surgeons. Dr. John Ridlon stated that he had never seen such a condition. Dr. E. W. Ryerson had personally observed 2 cases of this type and Dr. Kellogg Speed had had experience with a few of these cases and was convinced that a bone graft was necessary for their cure.

ETIOLOGY

All of the author's cases resulted from exceptionally severe trauma. Four of the patients sustained fractures of the clavicle as a result of automobile accidents. Four of them occurred after the original fracture was sustained by severe direct trauma to the clavicle, and 1 resulted from a fall upon the shoulder.

Cases 1 and 2 were subjected to operation for acute fracture within 1 week after injury—kangaroo tendon being used for internal fixation. Union might have been obtained in these 2 cases if reduction had been accomplished and adequate immobilization had been maintained.

In Cases 5 and 6 operation was done 7 and 5 months respectively after the original fracture. In Case 5, 4 operations were done: kangaroo tendon being used the first two times, a bone graft the third time, and wire at the fourth operation.

In Case 6 heavy braided silk was employed for internal fixation.

In Cases 5 and 6 fixation was not adequate after operation.

In Cases 3, 4, 7, 8, and 9 no previous operation had been done.

Four of the patients were in the third decade of life, 1 in the fourth, 3 in the fifth, and 1 in the eighth—the average age being 38 years.

There were 3 females and 6 males, a proportion of 1:2.

PATHOLOGY

Location. In all of the cases except one the fracture was at the junction of the middle and outer thirds of the clavicle, the one exception being near the external end of the outer third.

Gross description. In each of the cases as the site of the non-union was approached, the fractured ends of the clavicle were found to be enveloped by a thick, firm, fibrous sheath. When this was opened, a few cubic centimeters of clear, thin yellow fluid escaped. The inner lining of the fibrous encasement was smooth and soft and had embedded in it at various places, up to 2 millimeters in diameter, firm, gristly, smooth, shiny nodules, which were grayish-white in color.

In each of the cases there was found prominent bone spurs arising at the inferior and posterior aspect of the ends of the fragments.

Microscopic description of the pseudarthrosis, which was grossly described, is given with each respective photomicrograph (Figs. 3, 4, and 5).

Complication of non-union of the clavicle. In Case 4 there was an interference to the vascular return from the extremity. This resulted from pressure on the subclavian vein by the inner end of the outer fragment. The vascular phenomena were not constant in that they were altered with the change of position of the fragments.

Six of the 9, or 5 of the 7 patients operated upon, had complicating brachial plexus involvement. Definite structural injury to the plexus was not demonstrated in any of the cases. All recovered from the nerve involvement after restoration of the fragments to their proper alinement with the removal of the bone spurs, which were previously described, and the excess callus. The inference is that the restoration of the normal dimensions of the costoclavicular space relieved the brachial plexus from undue pressure or irritation.

In 1 patient (Case 9) who was not operated upon the brachial plexus involvement was present and the costoclavicular space was encroached upon by a calcified and ossifying mass, which was roentgenographically demonstrated.

Symptoms of non-union of the clavicle. Pain, which is usually along the course of the ulnar nerve, has been the most common symptom in this series of cases. Weakness of the intrinsic muscles of the hand has been a common complaint. A "clicking" sensation at the site of fracture on active motions of the arm has been a troublesome symptom.

On physical examination the findings were those of the characteristic deformity of angulation of the clavicle at the pseudarthrosis with the characteristic attitude of the shoulder which is dropped downward, forward, and inward.

In all cases the false point of motion was present and weakness of the muscles of the arm and hand was frequently noted.

Paresthesia and anesthesia along the ulnar nerve distribution was common.

Vascular disturbance characterized by blueness and coldness of the entire upper extremity occurred in 1 case.

Roentgenograms revealed the malposition of the fragments, the overriding when present, the obvious non-union, the presence of a hiatus of 3 centimeters in 1 case and, when carefully studied, invariably bone spurs revealed arising from the inferior aspect of the fragments. Foreign bodies dense enough to cast a shadow were demonstrated in patients previously operated upon.

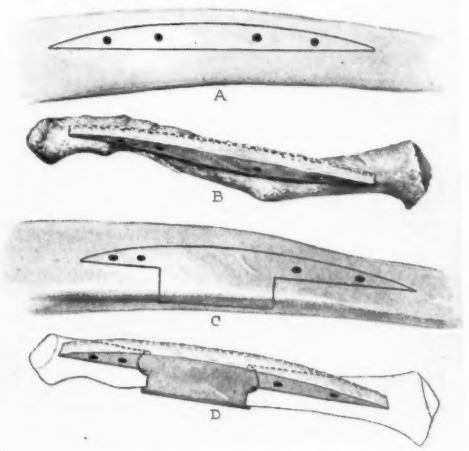

Fig. 6. A, Outline of onlay bone graft on the tibia. B, Autogenous osteoperiosteal onlay bone graft applied to fractured clavicle. C, Outline of combined inlay-onlay bone graft on the tibia. Note that the inlay portion includes the crest of the tibia. D, Autogenous osteoperiosteal inlay-onlay bone graft applied to a fractured clavicle with a hiatus.

TREATMENT OF NON-UNION OF FRACTURE OF THE CLAVICLE

Active. In delayed union or non-union cases or those in which there is marked deformity or interference with the function of the arm or hand, open reduction with union of the fragments by some method of osteosynthesis, such as bone grafting, is necessary.

In all the author's cases except 2, autogenous osteoperiosteal tibial bone grafts were used, the graft being applied laterally as an onlay graft at a point where the gap between the fractured bone ends were not great. A combined inlay and onlay graft was used when there was a considerable distance between the bone ends. The lateral graft (Fig. 6, A and B) was used in Cases 3, 4, 6, and 7 and the combined inlay graft and onlay graft (Fig. 6, C and D) in Case 5. In Case 1 a subperiosteal rib graft was used; while in Case 2 an osteoperiosteal sliding graft from the clavicle was utilized.

In all cases the periosteum should be dissected from the exposed bone ends for several centimeters and the bone ends should be cleaned of any exostoses and freshened. The ends should be hollowed out and the graft attached. Then the periosteum and soft parts should be sutured over

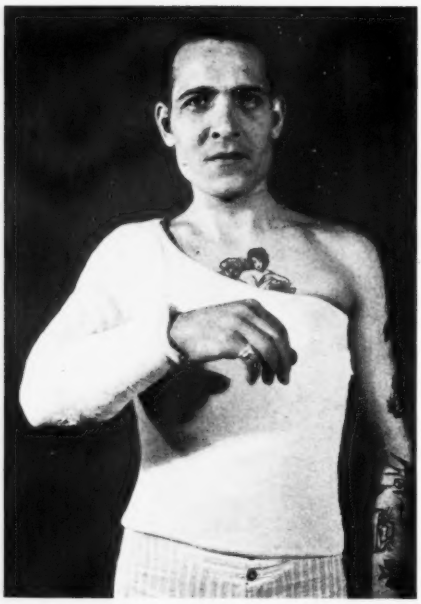

Fig. 7. Photograph showing the postoperative immobilization by a plaster shoulder spica.

the graft and the wound closed. In only one case was it necessary to shave off the inner end of the graft as it formed a projection under the skin. In no case was the graft removed.

At this time the author is unable to state what will be the ultimate fate of the graft, whether it will be absorbed by newly formed bone or whether it will itself remain viable. Although there has been internal fixation of the fragments by the massive osteoperiosteal bone graft, a most important part of the treatment, in addition to internal fixation, is that of external fixation by immobilization of the shoulder held upward and backward by means of a plaster shoulder spica from the time the wound heals until bony consolidation in good alinement is assured (Fig. 7). This usually requires about 12 weeks.

Technique. In order to avoid the disastrous complications of infection the operative field should have a 48 hour pre-operative preparation and then the operative area should be painted with iodine and alcohol at the time of operation.

After the shoulder and leg are draped, a semicircular incision is made below the clavicle from a point 1 inch lateral to the sternoclavicular joint extending nearly to the acromioclavicular joint through the skin, subcutaneous fat, and platysma muscle. This incision should be made so that the lowest point is at the level of the second rib; thus the line of incision will not be directly over the prominence formed by the graft. The flap is then turned up, and the skin edges are covered with towels most of the length of the clavicle with its muscular attachments being exposed. The periosteum is incised along the anterior superior margin of the fragments and is freed from them by subperiosteal blunt dissection; as the fractured ends of the fragments are approached, the fibrous tissue is dense and very adherent requiring sharp dissection. On the inferior posterior margins of the ends of the fragments there are found long bone spurs, which sometimes extend almost to the first rib. These bone spurs are found to be adherent to the fascial sheath of the nerves and vessels, hence should be removed with caution. On incision of the fibrous tissue between the fragments, a false joint is found to have developed in this location. After the ends of the fragments are freed for some distance the wound is covered with sterile towels. The tibia is exposed for a distance of 6 inches on its anteromedial surface through a longitudinal incision, and the skin margins are protected with towels.

The periosteum is not removed from the surface of the tibia, and particular care is taken to leave it attached to the bone. The size, length, and width of the graft which is necessary as previously estimated, is marked out on the tibia with a sharp knife. With a motor saw the graft is cut from the tibia—the full thickness of the cortex of the bone being used. After the graft is freed, but before it is removed from its bed, four drill holes are made in it, placed so that there will be two drill holes to correspond to two drill holes in each fragment of the clavicle.

The graft is then removed from its bed, care being taken not to remove any of the attached periosteum or medullary bone. Then the graft is applied to the anterior superior surface of the clavicular fragments so as to bridge the line of fracture. With the graft in place, drill holes are made in the clavicular fragments to correspond with those in the bone graft, after a flat retractor is placed under the clavicle as a protection to the important structures beneath.

In Case 5 it was found, when the ends of the clavicular fragments were freed so the shoulder could drop back to its normal position, that there was a hiatus of over 2 inches in the clavicle. It was decided therefore to cut the graft in such a way that it would have an additional "lug" on it, which could be interposed between the concave cut ends of the fragments. The exact fit, the

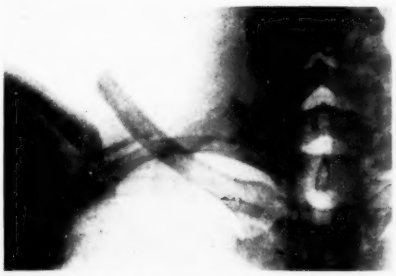

Fig. 8. Pre-operative roentgenogram, Case 3, reveals the marked separation of the ends of the clavicular fragments 5 months after injury. It also shows the downward and inward displacement of the inner end of the outer fragment with some callus on the inferior surface of the outer end of the inner fragment.

Fig. 9. Roentgenogram which was taken 5½ months after operation, Case 3, reveals a definite improvement of the position of the clavicular fragments, which are united by solid bony callus. It also reveals the increased width of the costoclavicular space. The osteoperiosteal onlay graft with its four drill holes is of approximately the same density as that of the underlying clavicle. It is firmly united along its course to the clavicle.

security of the fragments, and the end-result of firm bony union justified this plan and procedure.

The onlay bone graft is secured in position by heavy chromic catgut sutures, which are passed through the drill holes in the clavicular fragments and through the corresponding drill holes in the graft and tied around both. The periosteum, muscular attachments, and aponeuroses are then closed over the fragments by a continuous suture of strong chromic catgut. The wound is closed without drain, with a continuous suture for the subcutaneous tissue and with black silk for the skin.

The patients are placed on a flat, firm bed without pillows, but with a folded blanket between the shoulders after a snug Velpeau bandage is applied.

The sutures are removed in 2 weeks and then a plaster shoulder spica, which extends from the wrist to the iliac crests, is applied with the elbow flexed to a right angle, thus holding the shoulder upward and backward as far as possible.

The patients are then ambulatory for 10 weeks, after which the spica is removed provided bony union is demonstrable.

CASE REPORTS

CASE 1. M. W., female, aged 28 years, entered the hospital May 28, 1933, on account of pain in the region of the left shoulder and clavicle. Motions of left arm caused a "clicking" sensation at the site of the old fracture of the clavicle. After sleeping on the left side she noticed paralysis of the entire left arm. About 1 year before she was in an automobile accident and sustained a fracture of the left clavicle, which was set and a "T" splint was applied. One week later she had an open reduction. No splint was applied, but she was kept in bed 11 weeks. Physical examination revealed the characteristic deformity of shoulder with non-union of clavicle at junction of the outer and middle thirds. On May 29, 1933, she was operated upon according to the previously described technique, a fragment of rib being used as a graft.

On June 4, 1933, patient was discharged from the hospital with the plaster shoulder spica. Three months later, on removal of the cast, roentgenograms revealed firm bony union of the fragments.

CASE 2. E. F., male, aged 29 years, entered the hospital September 18, 1933, on account of pain at the site of the old fracture of the left clavicle radiating over the scapula to the chest and down the arm. On November 22, 1932, he was struck a severe blow with the handle of a pick, over the left shoulder fracturing the clavicle and causing numbness of arm. At open reduction on November 25, 1932, the fragments were fixed with kangaroo tendon and a Velpeau bandage was applied. Examination revealed a prominent middle third of the clavicle. Roentgenograms demonstrated an old ununited fracture of the clavicle at the junction of outer and middle thirds with displacement of the ends of fragments. On November 14, 1933, a sliding osteoperiosteal graft was done and an abduction splint was applied for 2 weeks. On December 28, he fell out of bath tub and injured clavicle again. Crepitus, swelling, and discoloration were present. A plaster shoulder spica was applied until April 16, 1934, when roentgenograms revealed bony union.

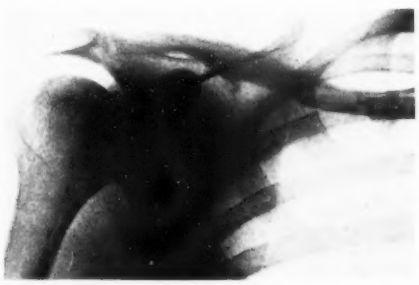

Fig. 10. Roentgenogram, Case 3, 2 years after operation, demonstrates solid bony union with disappearance of the onlay graft. There is hypertrophy of the clavicle with restoration of the costoclavicular space.

Fig. 11. Pre-operative roentgenogram of patient F. H., Case 4, reveals the characteristic malposition of the clavicular fragments with the tendency to develop spurs at their ends 1 year after injury. The shoulder girdle is relatively lower and the costoclavicular space is diminished. There is no evidence of callus formation.

CASE 3. P., male, aged 28 years, was struck on right shoulder July 5, 1933, by a falling steel beam, which caused a fracture of the clavicle and multiple other injuries. The arm was bandaged over the chest. On November 26, 1933, patient came to the author's service, complaining of weakness of the right arm, numbness of the little and adjacent half of the ring fingers, and old fracture of clavicle with non-union and discoloration of the fragments. Examination revealed the false point of motion and roentgenograms (Fig. 8) demonstrated rather marked separation of the fragments. On December 5, 1933, open reduction was accomplished according to the technique described. On March 24, 1934, roentgenograms (Fig. 9) revealed bony union between the fragments and between the graft and fragments.

Roentgenograms (Fig. 10) taken 2 years after operation demonstrate solid bone union.

Fig. 13. Pre-operative roentgenogram, Case 5, reveals the condition of the fracture of the clavicle 5½ years after the original fracture, and 18 months after the fourth operative attempt to repair the non-union. The clavicular fragments appear to have good alinement. There is a hiatus of approximately 3 centimeters with a loop of wire lying free between the ends of the fragments. The inferior posterior bone spur on the inner end of the outer fragment is clearly visualized. This spur diminishes the costoclavicular space.

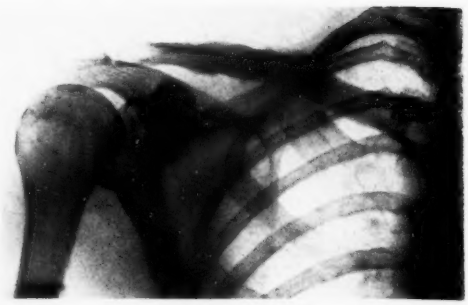

Fig. 12. Postoperative roentgenogram, Case 4, 10 months after operation, reveals normal alinement of the former fracture site with solid bony union. The osteoperiosteal onlay graft used has become fused with the underlying clavicle and is apparently of the same density. The ends of the graft merging with the callus from the superior aspect of the clavicle give the appearance of adaptation to the contour of the clavicle. The shoulder girdle is in normal position and the costoclavicular space is of normal width.

CASE 4. F. H., female, aged 41 years, entered hospital December 14, 1933, complaining of weakness of the arm and pain over the middle of clavicle, which resulted from fracture of the right clavicle sustained in an auto accident about 1 year ago. Physical examination revealed the nonunion of the fractured clavicle at junction of middle and outer thirds (Fig. 11). The arm became cold and blue when dependent. December 12, 1933, open reduction was accomplished according to the technique described. Twelve weeks later roentgenograms (Fig. 12) revealed bony union with normal position of the fragments. The subjective and objective symptoms have not recurred since the operation.

CASE 5. K., male, aged 49 years, entered the hospital complaining of pain and weakness on using the right arm, which resulted from an injury in November, 1929, when a large roll of paper fell on him causing multiple injuries, in-

Fig. 14. Roentgenogram, Case 5, taken 3 months after operation reveals normal alinement of the clavicle with solid bony union of the inlay-onlay osteoperiosteal bone graft to the previous clavicular fragments with restoration of normal length to the clavicle. The shoulder girdle is in normal position and the costoclavicular space is restored.

Fig. 15.

Fig. 16.

Fig. 15. Roentgenogram, Case 10, demonstrates fracture of the clavicle with malunion and vicious callus. The posterior displacement of the inner end of the outer fragment, which approximates the first rib diminishes the costoclavicular space. This view was obtained after a special study of the case with a portable "shock proof" unit of a fluoroscope, and the roentgenogram was taken with the tube at about the level of the fifth rib anteriorly pointing upward and backward with the plate in position above and behind the clavicle. In this case it will be noted that the costoclavicular space is encroached upon by the displaced fragment of the clavicle, hence the complication of the neurological symptoms.

Fig. 16. Roentgenogram, Case 10, of the costoclavicular space on the normal side. Roentgenographic technique is the same as in Fig. 15.

cluding fractures of both legs and right clavicle. The fractured limbs were treated by casts, but the clavicle was not treated, as he lay in bed for 10 weeks.

In May, 1930, he had open reduction of the fractured clavicle with immobilization by bandage for 9 weeks. This was repeated in June, 1931, and in October, 1931, the clavicle was operated upon again with a bone graft. Although he again remained in the hospital 10 weeks no cast was applied. In November, 1933, he entered the same hospital again and remained for 11 weeks, having had an open reduction with wiring of the ununited fragments. This was before he entered the author's service May 2, 1935.

On physical examination May 2, 1935, the right shoulder was found to be lower than the left, nearer the midline and somewhat anterior. There was a false point of motion in the mid portion of the clavicle and roentgenograms demonstrated the old ununited fracture in the middle of the right clavicle—the middle third was missing—with the shadow of a wire loop free between the ends of the fragments (Fig. 13).

On May 4, 1935, we operated according to the technique described. On removing the loop of wire and freeing the fragments so that the shoulder could drop back into its normal position there was a gap of over 2 inches between the ends of the fragments. The onlay graft technique did not appear to be a sufficient procedure, so it was decided to cut the long graft from the tibia with an extending "lug" at its middle portion, which could be inserted between the fragments as the onlay portion was applied to the fragments (Fig. 6, C and D).

Roentgenograms taken 3 months after operation revealed solid bony union of the graft to the fragments (Fig. 14).

Case 6. Z., male, aged 33 years, entered the hospital March 26, 1935, because of brachial plexus symptoms associated with non-union of an old clavicular fracture, which resulted from injury in an automobile accident June 5, 1934. He had only partially recovered from partial paralysis of the right arm. On October 29, 1934, open reduction was done, but he still complained of the nerve complication. On March 26, 1935, he was admitted to the author's service and was operated on again March 28, 1935, according to the technique described. The neurological symptoms disappeared before the cast was removed 3 months later. Roentgenograms at that time revealed good approximation of the fragments with union of the fragments restoring the normal costoclavicular space.

Case 7. S., male, 43 years of age, entered the hospital on September 8, 1935, complaining of pain and weakness of the right arm, as a result of old fracture of the clavicle with non-union, which was the result of one of many injuries sustained on February 28, 1935, when a wheel and cable of falling elevator struck him. On examination there was found non-union of an old fracture of the clavicle. On September 10, 1935, open operation according to described technique was done. Three months later roentgenograms revealed good position of fragments with bony union of fragments and union of graft to the fragments.

Case 8. T., female, aged 20 years, complained of tired sensation in her arms, especially the right. All motions of right arm caused a clicking in the right collar bone. She was injured in auto accident January 30, 1935, sustaining a fracture of both clavicles and tibia. Treatment consisted of rest in bed for 1 month as the tibia was immobilized in cast. Examination revealed a diminished distance between both shoulders, which were more anterior than normal. There was an increase in size of the middle third of the left clavicle while in the middle of the right clavicle there was a false point of motion. Roentgenograms confirmed the malunion of left clavicle and non-union of right clavicle as the patient consulted the author on January 11, 1936. Operative reduction of the non-union with tibial bone graft was advised.

Case 9. Dr. R. J., male, aged 70 years, was first seen on July 15, 1935, at which time he complained of weakness of the right hand with ulnar paresthesia. He injured the right shoulder on March 8, 1935, in an automobile accident. He had pain in the right shoulder, and after 8 weeks the patient developed pain and paresthesia along the ulnar nerve.

Roentgenograms revealed ununited fracture of the outer third of the clavicle with a shadow of an ossified hematoma in the costoclavicular space.

Conservative therapy was advised because of his age.

CASE 10. Male, 38 years of age, sustained an injury of the right shoulder November 1, 1935, when a plank fell on his shoulder. He had pain and loss of function for a few weeks, after which he had no complaint until December 15, 1935, when he began to develop weakness of the arm with tingling and pain in the hand. On examination there was found marked atrophy of the muscles of the arm and marked loss of strength while roentgenograms revealed an old fracture of the clavicle, which had firmly united with the characteristic deformity and excess of callus.

Operative correction of malunion was advised.

SUMMARY AND CONCLUSION

1. The literature on fracture of the clavicle with non-union is limited and opinions as to treatments are rare.

2. In the treatment of old ununited clavicular fractures in adults the use of the tibial bone graft with immobilization is recommended as the method of choice.

3. The costoclavicular space is diminished in the living as compared to the cadaver, because the vessels are distended and the nerve trunks are larger. In fractures of the clavicle this space is further diminished by the posterior displacement of the inner end of the outer fragment.

4. The inner cord of the brachial plexus which contains the fibers of the ulnar nerve passes downward to the arm directly over the first rib under the clavicle, while the other cords of the brachial plexus are located lateral to the first rib where there is a wider space and hence there is less liability of injury or later irritation.

5. The presence of the bone spurs, which were constantly found, although not always demonstrated in roentgenograms, because of their position, can be explained by the deposit of new bone from the periosteum, which was stripped from the clavicle by the force producing the original fracture.

6. The technique of the operation, which gave 100 per cent of successful results, is described.

7. A technique for taking roentgenograms more clearly to demonstrate the costoclavicular space is described.

8. Six of the 7 patients operated upon had preoperative neurological symptoms.

9. One patient with malunion, vicious callus, and late neurological complications, is reported.

10. A report is given of 9 personal cases of old fractures of the clavicle with non-union in adults, 7 of whom were operated upon according to the method described, with cure of the non-union and its associated complications.

FRACTURES OF THE NECK OF THE FEMUR

Fixation by Means of Kirschner Wires or by Smith-Petersen Nails

N. BACKER-GRÖNDAHL, M.D., Bergen, Norway

IN the October, 1936, issue of SURGERY, GYNECOLOGY AND OBSTETRICS, there appears an article by Frederick G. Dyas and Leon J. Aries in which they describe a method for the treatment of fractures of the neck of the femur by means of Kirschner wires. They found the method an easy and safe means of fixation of the fragments.

The same method has been used for several years in the Surgical Department of the Municipal Hospital of Bergen, and we know that the method has also been used by Schilling, director of the Surgical Department of the Municipal Hospital of Oslo, independent of us and without any knowledge that we used the method. The technique was the same as that described in the article by Dyas and Aries. At first the results were very promising. Difficulties developed later, however, which made us abandon the method entirely.

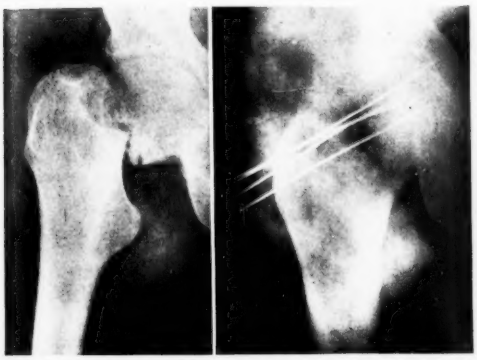

Fig. 1. B. H., female, aged 65 years, October 25, 1932.
Fig. 2. Reduction and "needling," November 9, 1932.

In our early cases, buried needles were used, but we found that the needles traveled, as happened in the following case. Director Schilling of Oslo had a similar case.

A woman, 65 years of age, had a subcapital fracture of the neck of the femur (Fig. 1), which we set by introducing 4 needles through the neck of the femur and then applied a plaster spica (Fig. 2). She was out of bed and walked around from the fifth until the thirteenth day, when she was ordered to bed because we did not trust enough in the strength of the plaster spica. Seven weeks after operation she was able to be up again and walked with crutches. The patient walked quite well and managed to lean on the fractured leg now and then. A few times she complained of feeling a pricking pain at the site of the fracture. By check up roentgenograms 10 weeks later we saw, to our great surprise, that one of the needles had traveled and that for the most part it was situated in the pelvis (Fig. 3). Through an incision in the trochanteric region we removed two of the needles and the third needle was removed through an incision above and parallel with Poupart's ligament. The needle was found deep in the pelvis but had perforated neither intestine nor bladder; it was removed in two pieces. The course was uneventful. Four weeks later the patient was able to be up, and she was discharged from the hospital with the fragments in good position (Fig. 4). She was then able to walk with a cane.

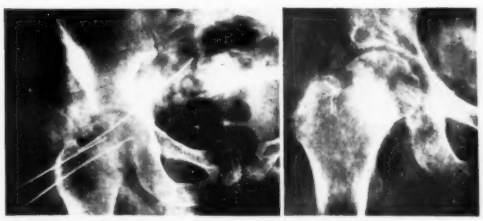

Fig. 3. Needle traveling into pelvis, January 5, 1933.
Fig. 4. End-result, March 1, 1933.

After this experience we gave up using buried needles. We left the end of the needle outside the skin and held it in place with a metallic knob. With this method, however, there was the danger of infection. One of our patients had an osteomyelitis which terminated fatally.

Although the method of using needles in the fixation of fractures of the neck of the femur has certain advantages, as pointed out in the article by Dyas and Aries, we have given up using it entirely. For many years we have been using instead the Smith-Petersen nail—nail with flanges—and have come to use the technique worked out by Johansson. We have found this method to be far superior and without danger even in very old and weak subjects.

Director, Surgical Department, Municipal Hospital.

FRACTURES OF THE PATELLA

GEORGE W. HAWLEY, M.D., F.A.C.S., Bridgeport, Connecticut

FOR the past 15 years, my associate, Dr. A. S. Griswold, and I have been using a method of treating fractures of the patella which has proved very satisfactory. During this time the method has been used as a routine measure with little variation in more than 100 cases.

The principal features of the method are these: No immobilization is used after operation. Voluntary motion is begun on the fourth day and walking without support on the seventh to the tenth. By the fourteenth day the knee is without dressing or protection, at which time there is free flexion of 60 to 90 degrees. Return of full motion, strength, and use averages from 3 to 6 weeks. The results run true to form with striking uniformity.

THE METHOD

Briefly, the technical features of the method are as follows: After being roentgenographed the leg is supported in temporary splints, the anterior surface of the knee being left exposed for careful preparation of the skin for operation and for the application of an ice bag to promote hemostasis. On the third to the fifth day, the fracture is exposed through a liberal vertical incision and the skin is retracted latterly and anchored with two strong towel clips to the sides of the knee, thus making the exposure diamond shaped. The skin is excluded from the field with sterile handkerchiefs fastened over the skin edges with Michel clips so that no skin is exposed. Only instruments and untouched materials come in contact with exposed tissue. Surgical trauma is limited. The internal part of the joint is not explored or invaded. Only the superficial blood clots are removed; the deeper ones are left. The fracture surfaces are carefully examined and the thin, adherent blood clot, usually present, is carefully and thoroughly removed with a small curette. As a rule, it will be found that the aponeurosis over the patella has been torn at a different level and overhangs one fragment. Two drill holes are made in each fragment and pointed dividers are used to space the holes so that they will match, one fragment against the other. Two short strands of strong Ajax-wire[1] are threaded through the holes to make two simple loops. This wire in quality is malleable, tough, easy to handle, and does not break or crack. Great care is used to draw each loop as tight as possible to impact the fracture surfaces. This we believe is important. Several twists make a strong knot which is cut, not too short, bent laterally, and buried under the aponeurosis to prevent protrusion under the skin. The torn aponeurosis and lateral expansions are sutured with catgut and the skin is closed.

Over the sterile dressings protecting the wound a very generous amount of absorbent cotton is applied, from midcalf to midthigh. Strong muslin bandage is used over the cotton and applied to compress the cotton firmly, especially over the joint. This helps to prevent and limit secondary exudate into the knee. Considerable pressure can be used without interfering with circulation, the cotton being compressible, soft, and fitting evenly the contour of the limb.

AFTER-TREATMENT

On the fourth day the muslin bandage is removed, the cotton is loosened and a loose gauze bandage is substituted. The patient is then asked to bend the knee. As a rule he can flex it from 10 to 20 degrees. At first, somewhat apprehensive, he is pleased to find he can get some motion. He is also requested to contract the quadriceps muscle and is instructed to practice frequently both joint motion and quadriceps contraction. He is warned that pain and fatigue are signals for him to go slow. He is cautioned to proceed slowly in his efforts to regain motion. At no time is passive motion used. The man is encouraged to work his own "motor" and work out his own salvation. Day by day the range of motion increases. This has a favorable psychological effect on the patient. The fact that he can see improvement encourages him and he takes pride in his progress.

It has been interesting to observe that, in some cases, voluntary quadriceps contraction is at first feeble, but this inhibition is transient and soon disappears. As a rule voluntary quadriceps contraction is spontaneous and immediate without

From the Orthopedic and Fracture Service of the Bridgeport Hospital. Presented in the Symposium on Fractures at the University of Pennsylvania Hospital by members of the Fracture Committee of the American College of Surgeons, during the Clinical Congress of the American College of Surgeons, Philadelphia, October 19–23, 1936.

[1]There are different sizes of this wire. Some are too light for the purpose. Gauge No. 18 has the necessary strength without being too clumsy and heavy. "Ajax-wire" is a high quality, rust-proof stove wire.

inhibitory restraint. The absence of the usual controlling protective mechanism is an interesting feature. It would appear that nature finds little need to establish protection and inhibit motion. The necessity diminishes with the restoring of tensile strength in the patella and does not exist when the strength equals the normal. Patients soon find they have the ability to bend the knee and sense the feeling of returning power. It is then often difficult to restrain them. When they find they can, they do, which is not surprising.

After the fifth day, if he feels the urge and has the confidence, the patient is allowed to get out of bed and walk without support, except a cane. When the skin has healed all dressings are removed.

RECOVERY

It has been surprising how rapid the recovery of function has been in some cases. In one case a machinist returned to his regular work 2 weeks after operation. A structural ironworker, whose work required climbing ladders and walking narrow beams, was back on the same job in 3 weeks. One man insisted on leaving the hospital on the fifth day and was at his desk on the tenth. Nothing would stop him. These are simply statements of fact and not made to convey the impression that coercion is used or advocated, or that such early use is to be expected or sought. On the contrary the patient is cautioned neither to hasten progress, nor to hold back. Our experience has been that the patient, all in all, is a better judge of what he can do than is the surgeon, and no harm has come from letting him be his own judge.

The rule has been that return of motion is rapid and prompt in all patients, with little variation. On the other hand there is more variation in the return of power and use in spite of free motion. Some patients are slower than others in this respect. Some delay is common in neurotic subjects, the timid, and unco-operative, those whose minds are more occupied with the settlement of a damage suit, and those not naturally "self-starters."

On the whole, the occupational recovery occurs on an average in from 3 to 6 weeks. In some cases the period has been 2 months and in a few cases 3 months, but in the majority of cases the recovery period did not exceed 6 weeks.

There have been a few particularly interesting cases. In one instance, only one, apparent refracture occurred. This was in a man who returned to factory work 3 weeks after operation, and 2 weeks later slipped on an orange peel. It was thought that the wires had broken but roentgenograms showed that the wires held and the fracture occurred at a level below the wires, the wires proving stronger than the bone. Thus it turned out to be a new fracture and not a refracture.

Fig. 1, left. Roentgenogram of recent transverse fracture of patella from indirect violence.

Fig. 2. Roentgenogram of same case after operation showing double wires and even alinement of posterior articular surface of patella. Patient out of bed seventh day, home on tenth with good knee motion, and full function end of fourth week.

In 2 cases, quite similar, fracture of the patella occurred in existing partial ankylosis of the knee following prolonged immobilization after compound fracture of the femur with infection and subsequent chronic osteomyelitis. At operation adhesions in the joint were found. These came into view without undue exploration and were divided. Both patients increased the range of motion; 1 from 70 to 90 degrees and the other from 60 to 75 degrees.

Another had tabes[1], which was overlooked until after operation and recognized only when absence of pain and ataxia became apparent. The patient let her leg drop and the wires tore through the softened tabetic bone.

There have been a few cases with, at a later date, fracture of the opposite patella and 2 cases of simultaneous fracture of both patellas. In one, both patellas were wired. The other presented a mid-transverse fracture of the right patella and a subaponeurotic fracture of the tip of the left. One was wired and the other was not. The wired patella recovered full use in 2 months. The other remained unstable and weak for more than twice as long.

[1]An intrinsic softening of bone substance sometimes occurs in tabes dorsalis with little or no change in internal structure as shown by roentgenographic examination. Spontaneous fractures occasionally occur in this disease.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 3. Roentgenogram of a recent comminuted fracture result of direct violence, and due to impact of flexed knee against dashboard of motor car. Showing spreading of fragments.

Fig. 4. Roentgenogram of same case (postero-anterior view) showing wire loop through upper fragment and patellar ligament, encircling and drawing fragments together.

Fig. 5. Roentgenogram of same case (lateral view) showing correction of separation of quadriceps tendon from patellar tendon. Wire appears as a figure of 8 because twisted end is bent laterally. Patient up at the end of second week, home at end of third week, 90 degrees' flexion 6 weeks after operation. Patient returned to work 2 weeks later.

COMMINUTED FRACTURES

The foregoing relates to the common type of transverse fracture due to indirect violence. In the comminuted or stellate type produced by direct violence, the double wiring as already

Fig. 6. Photograph of same patient 2 months after operation, just before return to work.

Fig. 7. Photograph of a patient 10 days after operation, showing knee flexion and quadriceps strength. Gauze is used to protect skin wound. Author's case taken from Scudder's textbook *Fractures*.

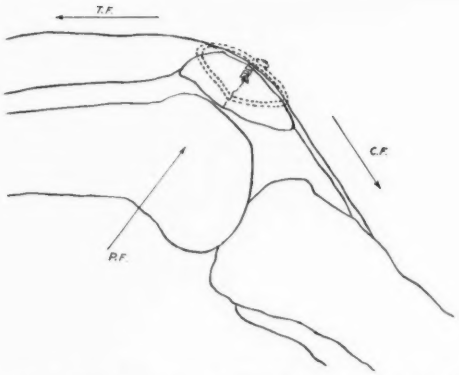

Fig. 8. Tracing of roentgenogram of a knee in partial flexion—the "rocker" position. Three forces are exerted on the patella; (1) *TF*, the traction force, (2) *CF*, the counter-traction force; (3) *PF*, the pressure force. The last is the force which produces the transverse fracture, the aponeurosis tearing and the patella cracking from front to back. It is also the force which tears and indicates the strength of the wire fixation. The two wire loops reinforce the patella in front where the strain is greatest and the four vertical strands of wire give double strength both in front and back.

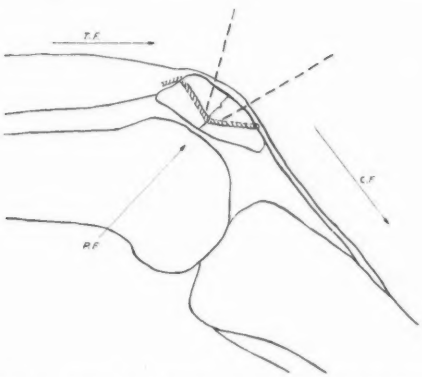

Fig. 9. Tracing of roentgenogram showing the single mattress loop. The strength of this method of fixation rests in the two strands of wire placed near the posterior surface of the patella. The pressure force from behind acts to open and separate the fracture line in front and when this happens the wires put in at an angle straighten out and separate the fragments. Mechanically, this is an imperfect method of approximation.

described is not applicable. In these cases a wire loop is used encircling the fragments. This tends to correct the spreading pieces of bone, drawing them together like a picture puzzle and provides a fairly strong and satisfactory approximation. The wire is passed laterally through the upper or lower fragment to get bony anchorage.

The after-treatment is much the same as in transverse fractures. No splints are used. They have not been found necessary. The natural protective inhibition automatically limits beneficial motion, if observed, and the limits cannot be exceeded without reprisals.

These patients first walk with crutches for a short time, changing to a cane. Progress is slower than in the transverse fractures. The approximation has not the same tensile strength. As a rule, however, the majority of these cases recover 90 degrees of flexion in 2 months, a few require 3 months. Many return to work in 3 months, some in 4, but few take more than that. That recovery is sometimes quite rapid in these cases is illustrated in a recent case of extensive fragmentation due to the impact of the patella against the dash of a motor car. The patient left the hospital on the tenth day and had free flexion and walked without a cane 2 weeks later.

The comminuted type of fracture has been more common, actually and relatively (in relation to the transverse type), in the last few years. Our records for the past year show 10 fractures of the patella of which 6 were comminuted and 4 transverse. This reverses the proportion of years ago, due in large measure to automobile accidents where the flexed knee is driven against the dashboard.

SUMMARY AND CONCLUSION

It is our belief that a patella doubly wired with strong wire is as strong, or stronger, than a normal patella, that a man can start motion as soon as the wound is healed, and that there is no reason why he can not.

The fact that in one case of apparent refracture the wires held indicates that the double wires are stronger than the bone.

Our rule has been to wire all patellas unless the subject is a poor surgical risk. Fractures with little separation are wired, on the basis that it promises much earlier recovery of use and escape from tedious convalescence and splints and plaster.

The wires are not removed. Removal is at the discretion of the patient who is told that the buried wire is harmless, that, if by chance, it becomes troublesome, removal is simple. As yet, no occasion has arisen necessitating removal of the wire.

While the effort has been to secure accurate alinement of the fragments by drilling from the fracture surfaces, no interference with function has yet been observed due to irregularity of the posterior articular surface.

It is our opinion that metal of most any kind buried in bone is harmless, if the surgical trauma is not excessive and the technique precise, that the idea of the harmfulness of metal *per se* is without basis of fact, that erosion of bone around a screw or wire is caused by low grade infection, that the blame has been mistakenly put on the metal and not the surgeon. We have not observed erosion of drill holes or loosened wire, clinically or roentgenographically.

It cannot be denied that non-operative treatment many times results in perfect recovery. But what an unnecessarily long time to wait, to protect and nurse a weak leg, before return to active life! The sacrifice is great and few choose it, unless consideration exists which make it advisable.

The wiring operation with drilling of bone is old but has been abandoned to some extent, due in part to illogical antipathy to the use of wire, to the fact that wire sometimes breaks, and to fear of infection. Silver, coin silver, has been more often used, but this frequently breaks in applying or afterward. Usually applied as a single mattress loop, its strength rested in a single strand. When used, it has been as a suture having more strength than heavy silk or gut and with little thought that a wired patella could be made to stand the strain of early motion or use.

The method of wiring herewith described differs only from the old in that a wire of proved strength and adaptability is employed, two loops are used instead of one, the fracture surfaces are impacted and artificial restoration of patellar strength is aimed at.

Formerly, the surgical objective was simple approximation of the fragments, but it can go a step farther. Instead of simple approximation, it is possible to effect at once a union of the fragments strong enough so a man can use the leg while the slow process of repair is going on within the knee. It is our belief that complete natural repair with restoration of patellar strength takes many months. This explains the tedious recovery of strength and usefulness after surgical approximation with weak sutures, in the unoperated upon patients with little separation, and the occasional occurrence of refracture during the first 6 to 12 months.

It is important to preserve the function of the quadriceps muscle, both its contractile and its elastic property. Both are quickly impaired through immobilization, neglect, and disuse. The loss of elasticity retards knee flexion and puts an extra strain on the injured patella.

The operation for repair of the patella is really a tenorrhaphy and the lesion partial or complete rupture of the quadriceps tendon, though it happens that the tear takes place through a bone as part of a tendon, which fact the surgeon can use to good advantage. Anatomically and physiologically the patella and patellar ligament are part of the quadriceps tendon, the patella placed behind acting to guide the tendon in the intercondylar groove. The anterior surface of the patella is an intimate part of the quadriceps aponeurosis. The posterior surface is covered with cartilage. Strictly speaking, it is not a true sesamoid bone imbedded and enclosed in a tendon.

Fractures of the patella and olecranon are the best examples where the ideal of fracture treatment can be applied and observed, that is, immobilization of the fracture surfaces, and mobilization of the entire limb at the same time.

To the injured man, especially the industrial worker, and the industry and insurance company which carry his liability, short convalescence and early return to work are important considerations. For the surgeon the obligation exists not only to repair the injured patella, but to put the man in the way to resume his occupation at an early date.

DEFORMITY OF THE WRIST FOLLOWING RESECTION OF THE RADIAL HEAD

RAYMOND W. LEWIS, M.D., and ARTHUR A. THIBODEAU, M.D., New York, New York

IN SO far as we know, attention has not been called to disturbance in alinement of the forearm bones at the wrist following resection of the head of the radius. That such a condition may occur was brought to our notice by the following case:

CASE 1. E. H., No. H11–449, female, aged 12 years at time of present history. At age of 9 years, she fell and fractured the head of the radius. She was treated conservatively elsewhere for 3 weeks, then came to this hospital August 15, 1932, complaining of limitation of motion in all directions. She entered the hospital August 18, 1932, and operation, consisting of excision of the head of the radius, was done August 19. Convalescence was uneventful. She was seen September 3, 1932, and showed excellent function. Patient again came to the clinic February 28, 1935, complaining of increasing discomfort and swelling over the lower end of the ulna. The symptoms and findings were so marked that a provisional diagnosis of acute osteomyelitis was made. Subsequent examinations and roentgenograms showed the ulnar head projecting below the radial styloid process, widening of the wrist joint, instability of the lower radio-ulnar articulation, with tenderness over this joint. The final diagnosis was malalinement at the wrist due to shortening of the radius and inflammation of the lower radio-ulnar articulation. Patient was treated with cock-up splint and physiotherapy and was found free from symptoms, July 8, 1935. Roentgenograms taken March 3, 1935, showed very marked shortening of the right radius at the wrist, as compared with the left. There was a wide space between the upper end of the radius and the capitellum, with no evidence of impingement or articulation, and with no regeneration of the radius (Fig. 1).

This case aroused our interest, and we attempted a follow-up of cases of previously resected radial heads. We were successful in obtaining return visits of only 7 other patients. Six of the 7 showed definite roentgen evidence of disturbed alinement of the radius and ulna at the wrist, the deformity consisting of shortening of the radius. The histories of these 7 cases are given here:

CASE 2. J. W., No. H17–180, female, aged 13½ years at time of operation. Patient was seen April 25, 1934, and gave a history of injuring the left elbow 7 months before. She had been treated conservatively elsewhere and came here because of marked limitation of motion in all directions. Diagnosis: fracture of the head of the radius. On November 9, 1934, operation, consisting of removal of bony body from the capitellum, and excision of the radial head, was done. Convalescence was normal. Patient was seen at follow-up clinic October 21, 1935, at which time she had no complaints. Flexion of elbow was found to be limited 10 degrees, and extension 15 degrees. Pronation and supination were complete. Roentgenograms of the wrists show moderate shortening of the left wrist as compared with the right. Roentgenogram of the left elbow shows a wide space between the upper extremity of the radius and capitellum, with no evidence of impingement of the radius against the coronoid process. There is no regeneration of the radius. It is thought possible that the shortening of the radius may become greater (Figs. 2 and 3).

CASE 3. A. D., No. H10–143, male, aged 17 years at time of operation. He was admitted to the hospital March 24, 1932, 3 months after fracture of the neck of the left radius. He had been treated by family physician and came in because of limitation of motion. Operation was done March 25, 1932, and consisted in removal of the head of the left radius. Recovery was uneventful and patient was discharged March 28, 1932. He was seen by us January 31, 1936, at which time he stated that he had no pain, but he had some feeling of weakness about the elbow after much use. He thought his elbow was about normal. He had noticed that the lower end of the ulna had become prominent during the past year. Examination showed that the left elbow looked like the right. Flexion, extension, pronation, were normal; supination was limited. The hand lies in slight radial deviation and the lower end of the ulna is prominent and is unstable. Roentgenograms of the wrists show that the left radius is slightly shorter at the wrist than the right. Roentgenogram of the left elbow shows that a deformed new radial head has formed and articulates with the capitellum. A large, apparently loose, newly formed bony body lies at the back of the radiohumeral joint, seeming to rest against the humerus and radius, almost like a sesamoid bone. This is somewhat similar to a case shown by Zeitlin. (Figs. 4 and 5.)

CASE 4. R. G., No. B20–126, female, aged 14 years at the time of operation. She was first seen May 13, 1928, at which time she gave a history of a fall a few weeks before, sustaining a fracture of the left radial neck. She had been treated conservatively in another hospital, and came in now because of limitation of motion in all directions. On July 21, 1928, the elbow had been manipulated under anesthesia, but satisfactory range of motion was not obtained. On October 1, 1928, the radial head was excised. Following operation patient developed von Volkmann's ischemic paralysis, but regained a good deal of function within 3 weeks. She was discharged October 27, 1928. On February 1, 1936, she was seen by us and stated that she had an extension fixation for about a year following discharge from the hospital. She then had a stretching under anesthesia at another hospital, and was greatly improved. No treatment had been given from that time until the present. She is dissatisfied with the result at the present time, as she has limitation of flexion, notices that the forearm is smaller than the other, and also that her wrist "turns in" (radial deviation). Inspection of the wrist shows radial deviation of the hand, but the lower extremity of the ulna does not seem prominent. Examination of the elbow shows moderate limitation of extension and much limitation of flexion. Upon extension of the forearm, after maximum

From the Departments of Roentgenology and Orthopedic Surgery, Hospital for the Ruptured and Crippled.

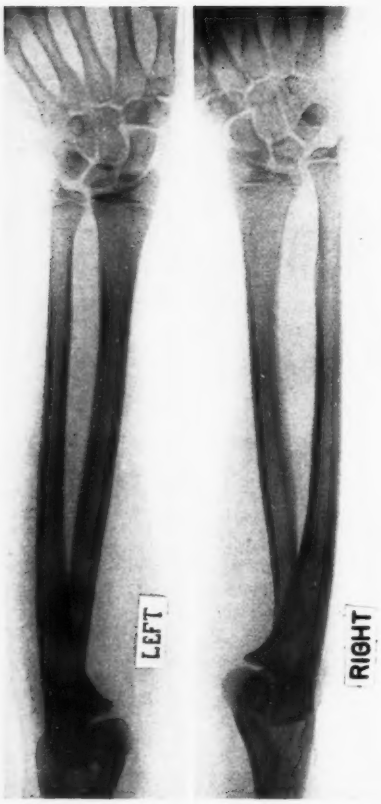

Fig. 1. Case 1. E. H., aged 12 years. Roentgenograms taken 2 years 7 months after resection of right radial head. Radius is short at wrist. Patient had severe and protracted wrist symptoms at this time.

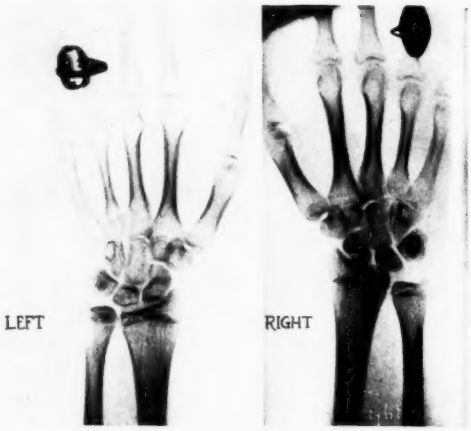

Fig. 2. Case 2. J. W., aged 14 years. Roentgenograms taken 11½ months after resection of the left radial head. The radius is short at the wrist. No wrist symptoms were noted.

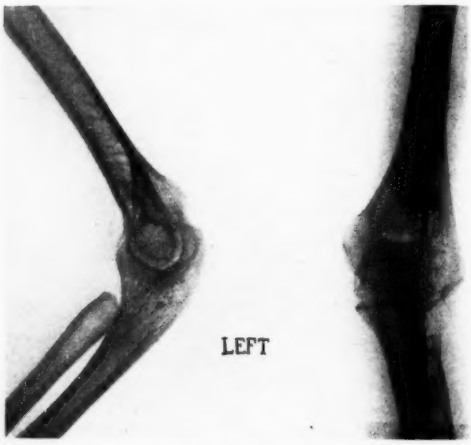

Fig. 3. Same patient as shown in Figure 2.

flexion of the elbow, a definite click is felt in the region of the upper extremity of the radius. Roentgenograms of the wrists show moderate shortening of the left radius as compared with the right. Films of the left elbow show that a small new radial head has formed, which articulates with the capitellum (Figs. 6 and 7).

Case 5. D. F., No. H10–823, female, aged 9 years at time of operation. Patient came to the hospital June 15, 1932, with a history of fracturing her right elbow 6 months before. Three days after the injury she was operated upon in another hospital. Following this she had a moderately stiff elbow, with limitation of all motions. Operation in this hospital, July 1, 1932, consisted in removal of the head of the radius. Recovery was uneventful and she was discharged July 5, 1932. She was seen by us February 6, 1936, at which time she stated that the result was satisfactory to her. Examination showed an increased carrying angle of the right elbow. Flexion, extension, and pronation were normal; 50 per cent limitation of supination. The radius appeared markedly shortened at the wrist, with much radial deviation of the hand. Roentgenograms of the wrists show that the right radius is very short; of the right elbow, that there is slight expansion of the upper end of the radius, and this appears to impinge against the lateral side of the coronoid process, with a space between it and the capitellum considerably greater than the humero-ulnar joint width (Figs. 8 and 9).

Case 6. R. T., No. B12–708, male, aged 16 years at time of operation. Patient was seen January 16, 1928, and gave a history of falling and injuring the right elbow 8 days before. Roentgenogram showed fracture of the head of the radius. He was treated conservatively. April 13, 1928, the head of the radius was excised because of limited elbow motion. He remained in the hospital under treatment for persisting limitation of elbow motion until June 27, 1928. On discharge he had only 135 degrees of exten-

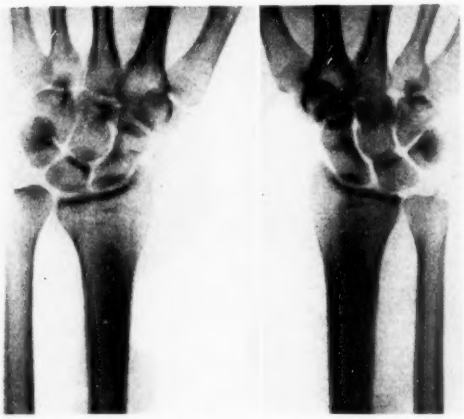

Fig. 4. Case 3. A. D., aged 21 years. Roentgenograms made 3 years 10 months after resection of the left radial head. The radius is short at the wrist. There are no wrist symptoms.

sion. He was seen by us February 10, 1936, at which time he stated that he had always had some limitation of extension. The arm bothered him when he carried heavy objects. Because of pain in the elbow and the wrist when shifting gears, he has had to give up his occupation as chauffeur. He has also noticed that he has a prominence on the inner side of his wrist, which is getting larger. Examination reveals a normal appearing elbow, with normal pronation and flexion. There is a slight limitation of supination, and extension is limited to 140 degrees. The hand lies in definite radial deviation, with the lower end of the ulna more prominent than in the other wrist. Roentgenograms show moderate shortening of the right radius at the wrist. The pointed upper end of the radius articulates with some unidentified bony body just below the capitellum, which prevents any further upward displacement (Figs. 10 and 11).

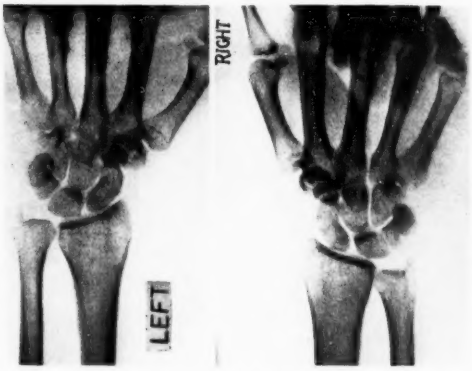

Fig. 6. Case 4. R. G., aged 21 years. Roentgenograms taken 7 years 4 months after resection of the left radial head. The radius is short at the wrist. No wrist symptoms are noted.

Fig. 5. Same patient as shown in Figure 4. Showing traumatic accessory bone.

Case 7. A. K., No. H16–369, female, aged 12½ years at time of operation. She was admitted to the hospital July 25, 1934, with history of fracture of the right elbow on July 13, 1934. X-ray examination showed a fracture of the radial head, in bad position. Operation, July 26, 1934, consisted in removal of the head of the radius. Convales-

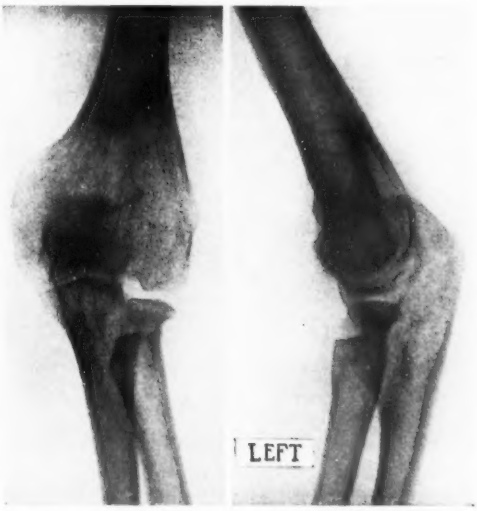

Fig. 7. Same patient as shown in Figure 6.

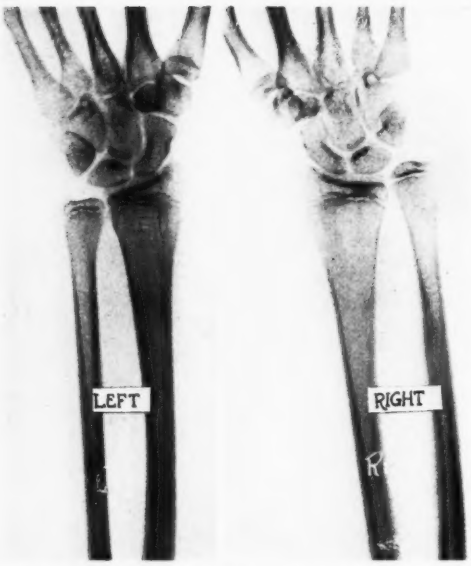

Fig. 8. Case 5. D. F., aged 12 years. Roentgenograms taken 3 years 7 months after resection of the right radial head. The radius is short at the wrist. No wrist symptoms are noted.

cence was uneventful and on discharge, August 8, 1934, there was satisfactory motion. She was seen by us April 18, 1936, and stated that she had been well since operation, with no complaint except that her arm tired easily when she carried heavy objects. She says that she has normal

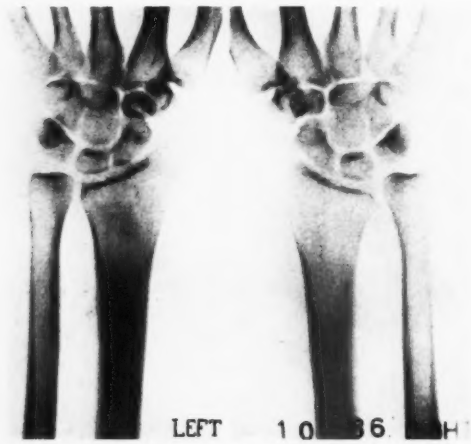

Fig. 10. Case 6. R. T., aged 23 years. Roentgenograms taken 7 years 10 months after resection of the right radial head. The radius is short at the wrist. Patient has disabling symptoms at wrist and elbow.

Fig. 9. Same patient as shown in Figure 8.

motion in the elbow and has no complaints about the wrist. Examination of the elbow revealed normal flexion, extension, and pronation. There is moderate limitation of supination; moderate shortening of the radius at the wrist was visible on inspection. The lower end of the ulna did not look prominent. There was slight radial deviation of the hand. Roentgenograms showed moderate shortening of the right radius at the wrist as compared with the left. Roentgenogram of the elbow shows a small new radial head, apparently articulating with a small facet on the lateral side of the coronoid process. The space between the new radial head and the capitellum is a little greater than

Fig. 11. Same patient as shown in Figure 10.

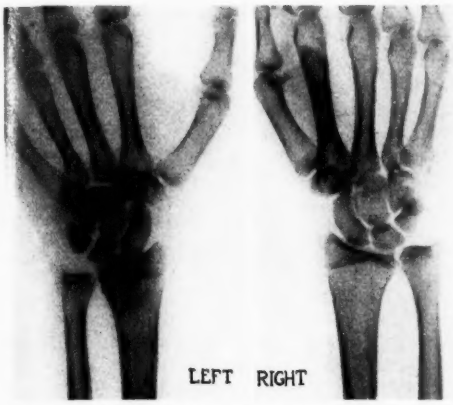

Fig. 12. Case 7. A. K., aged 14 years. Roentgenograms taken 1 year 9 months after resection of the right radial head. The radius is short at the wrist. No wrist symptoms are noted.

the joint width between the ulna and the humerus (Figs. 12 and 13).

Case 8. E. Del C., No. H20–213, male, aged 30 years at time of operation. Patient was first seen September 11,

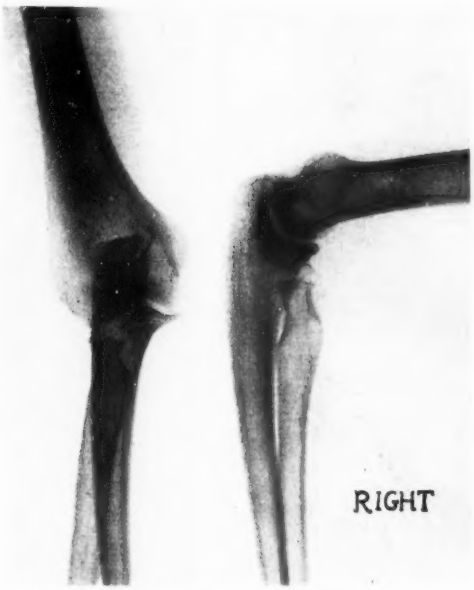

Fig. 13. Same patient as shown in Figure 12.

1935, when he stated that 5 months previously he fell and fractured the head of the radius and the olecranon process. Fragments of the olecranon process were reduced and fixed with a wire in another hospital. Patient came for treat-

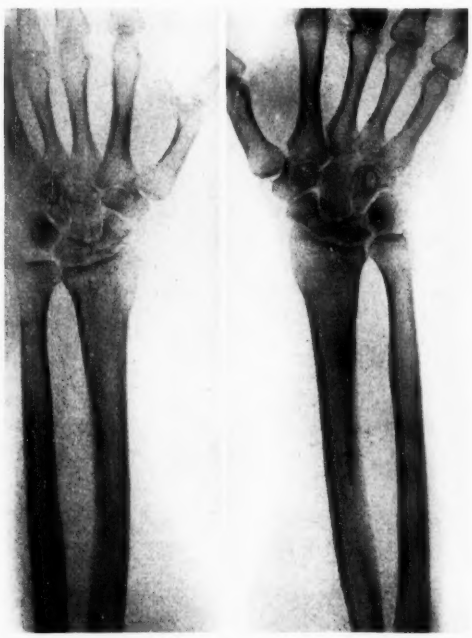

Fig. 14. Case 8. E. Del C., aged 31 years. Roentgenograms taken 10 months after resection of the left radial head. The radius is not short at the wrist. No wrist symptoms are noted.

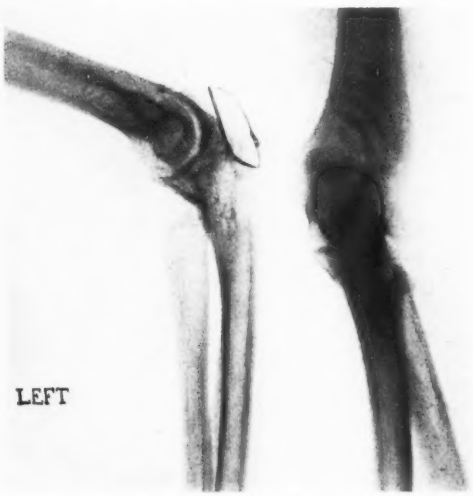

Fig. 15. Same patient as shown in Figure 14. Absence of upward displacement of radius is probably due to impingement of the upper end of the radius against the coronoid process.

ment because of a marked limitation of motion in all directions. He was admitted to the hospital September 18, 1935. The head of the radius was excised 2 days later. Recovery was uneventful and he was discharged September 30, 1935. On November 13, 1935, he was seen again and was found to have full rotation, 20 degrees of limitation of extension, and normal flexion. July 11, 1936, examination showed no visible shortening of the radius at the wrist; elbow showed slight limitation of both pronation and supination; very slight limitation of flexion and extension. Roentgenograms showed no shortening of the left radius at the wrist. They showed some irregular productive changes at the proximal end of the radius. A small projection on the upper extremity of the radius seems to form a stable articulation with a small flat facet on the lateral side of the coronoid process, probably the distal margin of the lesser sigmoid fossa. This appears to prevent upward displacement of the radius (Figs. 14 and 15).

Seven of these 8 cases of resected radial heads showed on roentgen examination more or less shortening of the radius at the wrist. In the eighth case (E. Del C.), impingement of the upper end of the radius against the coronoid process of the ulna is the probable explanation of absence of upward displacement of the radius. On careful physical examination, all the patients except the one showed a degree of deformity varying from slight to marked. This deformity consisted of radial deviation of the hand and prominence of the lower extremity of the ulna, somewhat similar to the residual deformity which follows a Colles' fracture which has not been completely reduced.

No significant limitation of motion of the wrist was found, though some did show slight limitation of adduction.

Two of the 8 patients had definite complaints referable to the wrist, one of sufficient severity to prevent his following his occupation as chauffeur. Pain brought the other patient to the hospital for a period of treatment, and was of such severity as to lead to an original incorrect provisional diagnosis of acute osteomyelitis.

THEORIES AS TO THE MECHANISM OF THE UPWARD DISPLACEMENT OF THE RADIUS

Factors which would seem of importance in producing this deformity are the following: removal of bony support for the radius at the elbow; loss of the support of the orbicular ligament; stretching of the interosseous membrane and lower radio-ulnar ligaments; upward pull of such muscles as the biceps, brachioradialis, and extensor carpi radialis longior and brevior; and loss of the growth center at the upper end of the radius.

That this last is not of major importance is indicated by the fact that 2 of our patients who showed shortening were beyond the age where growth would be a factor.

The determining factor in limiting the upward movement of the radius we have not determined with certainty. In some cases the radius appeared to be stopped by impingement against the capitellum, and in others by impingement against the coronoid process of the ulna. Still others did not present evidence of bony impingement, which might mean that the maximum deformity had not yet been reached, or that the limit of elasticity of the soft tissues had been reached.

Although some of our cases showed a certain amount of new bone formation about the proximal end of the radius after resection of the head, none showed any such degree of regrowth as described by Sutro. Sutro makes no mention in his cases of bony relations at the wrist. In view of the findings in our small group of cases, it would seem possible that some of the filling in at the elbow in Sutro's might be due to upward displacement of the radius as well as to regeneration of bone. Judging from the roentgenograms alone, such a possibility would seem especially likely in his Case 3.

SUGGESTIONS RESULTING FROM THIS STUDY

This series is much too small to warrant any final conclusions. It does suggest, however, that the decision to resect the radial head should not be made casually, and with no thought of conditions except those at the elbow. Consideration should be given to the probability that a certain amount of deformity of the wrist will result from this procedure, possibly sufficiently great to distress the patient. And there should be realization of the possibility of subsequent development of troublesome wrist symptoms.

Limiting the amount of excised bone to a minimum might be helpful in avoiding or limiting wrist deformity. Whether, in order to prevent upward displacement of the radius, it would be possible or practicable to create at the time of operation a new joint between the radial stump and coronoid process, such as appears to have formed spontaneously in a few of these cases, we are not in a position to say.

SUMMARY

Shortening of the radius at the wrist followed resection of the radial head in seven out of eight patients.

The extent of the deformity which was visible at the time of physical examination varied from slight to marked.

The deformity was somewhat similar to the residual deformity of an incompletely reduced Colles' fracture.

Two of the eight patients had disabling symptoms referable to the wrist.

Theories as to the mechanism of the upward displacement of the radius are mentioned.

Suggestions resulting from this study are submitted.

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ECONOMIC ADVANTAGES OF EARLY PROTECTED WEIGHT-BEARING IN FRACTURES OF LEG, FOOT, AND ANKLE

FRASER B. GURD, F.R.C.S.(C.), F.A.C.S., Montreal, Canada

IN PREVIOUS communications I have indicated certain untoward complications and sequelæ which occur following fractures below the knee, and which are avoided in large measure by a method which permits early protected weight-bearing. The important unfavorable conditions thus influenced are:

1. Delayed or—in unusual cases—non-union.
2. Prolongation or permanence of interference with joint function.
3. Contractures and consequent interference with the action of muscles and tendons.
4. Circulatory disturbance, manifested by swelling and loss of tolerance to low temperatures.
5. Pain upon weight-bearing due to decalcification of bone and ligamentous structures—phenomena which when excessively marked have been discussed under the heading "Post-Traumatic Acute Bone Atrophy."

The economic advantages referred to in my title are not primarily meant to indicate the better end-results or the shorter period which need elapse between receipt of injury and recovery of function following consolidation of fracture. It is my purpose to show that by the employment of the author's technique much time may be saved during the early stages of treatment, and that resumption of approximately normal activity by many patients may be undertaken before bony union has, in fact, commenced.

In private practice early return to substantially full activity on the part of professional and business men is, as a rule, very much appreciated. Clerical workers and, more particularly, business executives are able to attend their offices and to carry on a usual day's work without difficulty. The same applies to housewives, including the usual necessary duties in the home, not excluding the care of children. The employers of domestic servants can be informed that it will not be necessary for the housemaid or cook to remain off work for many days because of a fractured ankle or a broken foot. In consequence, employment of such domestic servants is maintained and the routine of the home often materially assisted. Pupils and students at schools and universities need lose but little time and are able to carry on without finding life unduly irksome.

From The Montreal General Hospital.

Although, hitherto, I have not found it possible to arrange for the return to duty of more than an occasional individual coming under the control of the Workmen's Compensation Commission, the fact that the total temporary disability period of the group of fractures under consideration in this contribution is very expensive to both commissions and workmen will, I believe, result in reconsideration on the part of commission boards which will make it possible for many men to continue at work during the, sometimes, prolonged period required for consolidation and complete return of unprotected function to take place. For such a condition of affairs to be brought about, considerably more co-operation between employers, commission boards or insurance companies, practicing surgeons and workmen will be required than at present exists in most districts. Prior to the establishment of a Board to handle cases of injury among workmen in the Province of Quebec in 1928, it had been possible for me to arrange for the return to duty of a reasonably large number of cases in which compensation was the responsibility of either employer or insurance company.

It is my hope that ere long not only will it be possible to obtain the co-operation here indicated but it may be that three of the interested parties —employer, compensation board or insurance company, and workman—will demand the serv-

ices of a surgeon competent to apply an apparatus which will make it possible for many, or perhaps most, injured working men and women to return to duty safely and usefully during the period required for consolidation of fractures of bones of the lower extremities, at least below the knee.

Those surgeons who have had experience in the treatment of fractures by any method which permits early weight-bearing will agree, I believe, that the end-results so obtained are better, and are reached more quickly, than by the traditional method of reduction, application of a padded cast, and either bed rest or a dangling limb with crutches.

I have previously published a somewhat critical review of the advantages and disadvantages of the three more generally employed methods of treating such fractures and which at the same time allow the patient to walk without the help of crutches. The three methods so considered were those of Delbet, Boehler, and my own. Briefly, the objection to Delbet's method is that the support given to the injured limb is usually not adequate and swelling is permitted to take place. In consequence, patients so treated are unwilling to bear their whole weight upon the injured limb and, furthermore, injury to the tissues in consequence of the edema which ensues is all too frequent.

The objections to Boehler's technique are that the plaster, as applied by him, is bulky depending as it does primarily upon a posterior molded piece for its strength and, more particularly, because the steel stirrup which he employs, although it is adequate in so far as the protection of the plaster is concerned, is not easy to walk on and prohibits the wearing of a proper boot. Since I believe that early return to work, be such employment professional, clerical, or manual, depends in large measure upon adequate protection of the, not very durable, plaster-of-Paris appliance and also upon its relative inconspicuousness, I am convinced that my own method has definite advantages over that of Boehler.

Although publication of the author's method was delayed until 1928, the method of early protected weight-bearing employing substantially the method recommended at present, has been used in several hundreds of cases since 1919.

The author is of the opinion that, granted adequate reduction has been obtained, the group of unfavorable developments tabulated in the first paragraph of this paper may be avoided, or at least their incidence and severity lowered, by a method which permits early weight-bearing.

Delayed union. Among the methods suggested and employed to stimulate bone union in cases in which this process has been delayed or appears not to be taking place, that of Owen Thomas, as popularized by Sir Robert Jones, of exposing and hammering the bone ends, has proved itself to be of real merit. By means of protected weight-bearing in the manner recommended in this contribution, a compromise on this technique is obtained, in that, although the broken bones are subjected to but little strain, nevertheless, the site of fracture is kept constantly irritated with, in consequence, stimulation of an adequate blood supply and, apparently also, of osteogenetic function.

A recent article of Kuentscher abstracted in the August number of *International Surgical Digest*, upon the influence of traction and pressure on the healing of fractures, has been of very considerable interest. Kuentscher's argument, based upon experiments by himself and others, is that if callus is under the influence of traction pseudarthrosis is the result; if it is under the influence of pressure, bony union may be expected. Kompecher, he says, performed experiments whereby, by means of wires through the fracture ends, he produced at will fibrous or bony union. By pulling the fragments asunder—fibrous union, by pressing them together—bony union results.

Joint function. Interference with joint function in consequence of prolonged rest of the member is, in part at least, due to atrophic changes dependent upon alteration in blood circulation which are apparently due to influences brought to bear through the nervous system, presumably through the reflex arc. When the patient suffering from a fracture of one or more bones below the knee continues modified weight-bearing upon the limb, approximately normal afferent stimuli from the joint surfaces are induced. In addition also, the circulatory efficiency under these conditions inhibits the atrophic changes in, and about, the joints. It will require but few experiments to convince the doubter that movements of the knee, ankle, and foot joints are re-established to a practically normal degree in a very much shorter time in cases in which patients have been ambulant, with weight-bearing, than in similar cases in which patients have been either confined to bed, or have walked with crutches, without functioning of the injured limb.

Muscle function. Although a properly applied circular cast so fixes the joints of the limb that practically no movement takes place, such interference does not prevent contraction and sliding of the muscles and, to a lesser degree, of the ten-

dons of the limb. It is a matter of every day knowledge that muscles induced to exercise against a fixed restraining force may be kept normal in size and activity. At the same time, such functioning of the muscles stimulates a more nearly normal volume of blood to enter and to circulate through the limb, as a whole.

Circulatory disturbance—swelling. There is no necessity to urge the fact that fixation of the injured limb either with the patient in bed or walking, with crutches, with the extremity dependent in a plaster cast, applied over padding, almost invariably anticipates a period of moderate to marked swelling of the leg and foot when, support being removed, the limb again becomes dependent. Various explanations of this phenomenon have been offered, the most probable of which is that the veins and lymphatics, due to loss of functioning, become incompetent and, also, that due to stretching of the interstitial areolar tissue, potential dead spaces are created. It is also commonly noted that such swollen limbs habitually exhibit an objective sensation of coldness in the toes and, more or less, of the foot and that, subjectively, the patients complain of cold when the limb is exposed to low temperature. If, during the necessary period of bone consolidation, the limb remain dependent for much of the day and if, in consequence of the confining effect of plaster of Paris accurately molded to the leg and foot, swelling of the limb be avoided, neither of the foregoing unfavorable phenomena are likely to be exhibited later. In consequence of the more or less normal stimulation of skin, bone, joint, and muscle, sensory nerves maintain their effect upon the reflex arc and, in consequence of the maintenance of the pumping effect of the contracting muscles, not only is an approximately normal amount of blood induced to enter the limb but stasis of blood in the capillaries and vessels is prevented.

Acute bone atrophy. Acute bone atrophy would appear to be of considerably more importance in increasing pain on the part of the patient, more particularly those who have suffered from comparatively trivial injuries, than is usually appreciated by surgeons. At the same time, its development undeniably prolongs to a very important degree the period of disability. It is not the author's intention in this contribution to discuss, *in extenso*, the phenomenon of acute (Sudeck's) bone atrophy but to point out that in his experience the most favorable treatment for the condition when exemplified in the lower extremity is the application of a walking plaster cast and the resumption of active function on the part of the limb. The comparatively small incidence of acute bone atrophy among the author's cases, as compared with the relatively large number of examples of the affection in fractures treated by more traditional methods which have come under his observation, would appear to support the view expressed in this and previous contributions, that acute bone atrophy in the lower extremity is most surely avoided by the employment of a technique which permits protected weight-bearing during the period required for consolidation of the fracture.

AUTHOR'S TECHNIQUE

Foot and ankle fractures. If the fracture of foot or ankle is seen and reduction is accomplished very soon after injury, i.e., before swelling has occurred, a walking plaster may be applied at once and the patient may commence weight-bearing, and consequently return to duty the following day. As a rule, however, the patient is not seen thus early and swelling or hematoma formation has already taken place. In such cases the fracture is reduced and, after a preliminary period of from 2 to 12 days, during which time disappearance of swelling of the limb is brought about, chiefly by posture assisted in some cases by baking and gentle massage, a discarded silk stocking is placed over the limb, from the tips of the toes to the knee. The limb itself is previously carefully washed with soap and water, bathed with alcohol and rubbed with zinc stearate powder. If *bullæ* have been present, they are treated as indicated, and the neighboring area painted with an antiseptic solution. Care is taken that no wrinkles appear in the stocking, particularly in the neighborhood of the ankle. Circular plaster-of-Paris bandages are then applied to the limb without the application of padding.

Great care is taken in the application of the circular cast that no dead spaces exist beneath it and, above all, that no constricting bands of plaster are applied. Before the cast has set, it is carefully molded about the malleoli and to the upper end of the tibia. The foot is fixed at a right angle at the ankle joint, pressure upon the inner or outer border of the foot is maintained, depending upon the nature of the injury, and the mid foot is flexed so that the first and fifth metatarsal heads are on the same plane.

Since it has been noted that the majority of patients wearing artificial limbs for amputations through the leg prefer to have some of their weight borne upon the lower border of the patella and, since the upper portion of the plaster cast is, in fact, to be employed in the same manner as the bucket of an artificial limb, the cast in

Fig. 1.

Fig. 2.

Fig. 1, left. Properly applied plaster, with felt heel attached, which has been worn for 10 weeks with the patient walking without crutch or stick. Note the anterior upper border pressing upon the lower border of the patella and, also, the covering of the fourth and fifth toes.

Fig. 2. Plaster partially applied in a case of fracture of both bones of the leg. Note stirrup of plaster which reinforces heel, ankle joint region, and site of fracture.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 3. Custom made boot designed to go over plaster. Note that lacing extends down to the toe.

Fig. 4. Custom made boot designed to go over plaster. Such a boot is recommended for women who are in a position to afford such an appliance.

Fig. 5. Custom made boot which has been designed to go over plaster. Note that the lacing in this boot is carried up the back. This type of boot is especially recommended for use by men who must engage in heavy manual labor.

cases of fracture of the foot and ankle has been carried up so as to fit the lower border of the patella, in front. The posterior border of the upper end of the cast is cut away sufficiently to permit flexion of the knee to a right angle. The author has made it a practice to include the fifth and, usually, the fourth toes in the plaster, as painful pressure points are thus more surely avoided.

In the application of the plaster cast the fact that the weight of the patient is to be carried from the heel of the plaster to the upper border of the tibia is borne in mind, and special care is taken to provide sufficient strength in order that this may be carried out. In my experience, the weak points of the plaster are the lower surface of the heel, across the anterior border of the ankle joint, and about the junction of the middle and lower thirds of the leg. These parts may all be strengthened by a loop of plaster carried around the heel to about the middle of the leg (Fig. 1).

As soon as the plaster of Paris is dry, that is usually the day following its application[1], a saddler's felt heel, 1 or 1½ inches in thickness, is fixed to the sole of the cast by means of adhesive plaster. We have employed the method of incorporating the felt under a few thicknesses of plaster at the time of the original application but are of the opinion that, although a neater job is obtained in this way, the technique recommended is the better.

The patient commences walking at once, preferably without the help of either crutch or stick. The length of time during which the walking plaster is worn will depend upon the severity of the original injury, and the bones involved. Since the patient is able to move about early, and since swelling and stiffness are largely eliminated by the technique recommended, there is less objection to prolonged fixation than were a method used which required any considerable length of time before the re-establishment of function, following removal of the plaster.

In the treatment of fractures of the metatarsal bones and of the great toe, a similar technique is employed. Unless deformity is such that some special form of reduction is indicated, after a sufficient period of rest to permit swelling to subside, an unpadded plaster which in this case extends beyond all the toes and may well be made to cover all five toes and reach to the upper border of the tibia, is applied. The author feels convinced that, although this method of treatment may at first appear cumbersome for limited injuries of this nature, the period prior to return to work is lessened thereby and, in the second place, unfavorable sequelæ are avoided.

In cases of great toe fractures a period of active walking for 6 weeks usually suffices and, as a rule, within a very short time after removal of the plaster, the patient is able to return to full duty.

Both bones of leg. In the treatment of fractures of both bones of the leg, the method employed differs from that used in the case of fractures of the bones of the foot or about the ankle joint. Reduction, as promptly as possible following injury, is accomplished by means of traction; for this purpose either a modification of the Delbet sling or skeletal traction with Kirschner wire or wires is used.

As is well known, it is usually impossible to place the foot at a right angle to the leg in cases of fracture of both bones of the leg, without producing posterior bowing at the site of fracture; consequently, it is usually necessary to fix the limb in a preliminary plaster in a position of more or less marked talipes.

Such preliminary fixation is allowed to remain undisturbed for a period of from 18 to 24 days. During the latter part of this period, the foot of the bed is elevated by 8 or 10 inch blocks and, about the time when it is expected that fixation of the bone fragments will have commenced, the cast is bi-valved, in order that inspection may be carried out and baking and light massage employed. At the same time, the patient is urged actively to attempt to dorsiflex the ankle joint (Fig. 2).

As soon as it becomes evident (usually about 3 weeks from date of injury) that sufficient stability of the limb is exhibited so that it may be handled and the foot brought to a position of a right angle with the leg, an unpadded plaster-of-Paris cast is applied over a silk stocking. This cast reaches from the junction of the middle and upper thirds of the thigh down to the toes, and includes the fourth and fifth toes. The knee is fixed in full extension, and the ankle joint at a right angle. The mid foot is flexed so as to re-establish the longitudinal arch. As in the case of fractures of the ankle, special care is taken to reinforce the bottom of the heel, the ankle joint region, and the leg, to well above the site of fracture by means of a plaster stirrup; a felt heel is then applied. The patient is then urged to walk; during the first 2 or 3 days, as a rule, he will prefer to carry part of his weight on crutches.

When clinical and radiological examination appears to indicate firm consolidation, I have

[1]Drying of the plaster is hurried by the employment of a baking machine.

made it a practice to remove the long plaster, immobilizing as it does knee, ankle, and foot joints, and to replace it by a protective dressing, by a Delbet plaster, or by one of the type used for ankle joint fractures.

Custom made boots. The author is of the opinion that the chief advantage of his method as compared with that of Boehler is the comparative ease with which a boot may be made to go over the plaster. Such boots may be so fashioned that they are not particularly noticeable and, in any event, can be made to look neat so that the patient, whether man or woman, is able to go about his, or her, affairs without being unduly conspicuous and, consequently, without embarrassment.

It is obvious that the plaster encased foot cannot be put into an ordinary boot; the absence of foot movements and ankle joint movement makes it necessary that the boot be so made that the foot may be laid in it. Two methods have been employed to make this possible. In one, the boot is so made that it laces down close to the toe cap. If the lacing is undone, it is a simple matter to lay the foot in the boot and then to lace it up in the usual way. This makes the foot covering neat and secure. The other method is to make the fore part of the boot of solid leather and to have it lace up the back. In this type, the foot is pushed into the boot from behind, and the lacing then completed.

Four separate types of footwear have been designed; these have been made for the individual patient, in part depending upon the type of activity which is to be engaged in, and in part upon the financial resources of the individual. In the usual type, such as is worn by business executives and professional men, a boot similar to that illustrated in Figure 3 is made by a custom bootmaker. Such boots can be made both with, and without, a heel. If the heel is attached to the under surface of the boot, no felt heel is attached to the plaster. In general, the statement may be made that it is more satisfactory, as a rule, to attach a felt heel to the plaster and to have the boot made without a heel.

The second type has been worn by women and is illustrated in Figure 4. This is not, of course, inconspicuous but is neat and is worn by business women and others without embarrassment.

The third type has been most suitable for those who wish to engage in heavy occupations. As shown in the illustration (Fig. 5) it is made of heavier leather and, the fact that it is not weakened by lacing down the front, makes it more durable.

The fourth type is in the nature of a slipper and has the advantage of being much less expensive than the other varieties; it is laced up the back.

In Montreal, the cost of custom made boots, other than the high boot for women, is between ten and twelve dollars. The slipper-like covering can be made for from one to two dollars. Patients for whom funds are not available purchase a simple foot covering—a large moccasin or felt slipper. It is inadvisable to permit the patient to wear a rubber covering since the moisture is likely to soften the plaster.

SUMMARY AND CONCLUSIONS

Since the Autumn of 1918, the author has employed the method recommended in this and previous contributions, as a routine, in the treatment of (1) fractures of both bones of the leg, exclusive of those involving the knee joint; (2) all fractures of the ankle joint and (3) all fractures of the tarsus and metatarsus, as well as (4) fractures of the great toe and, occasionally, of the smaller toes. Many hundreds of fractures have been treated by this technique. I have had no occasion to regret the use of the procedure in any one case, and in a number of patients who had not been progressing favorably, improvement has been noted soon after the application of the walking plaster. One case only of non-union has occurred and but one of acute bone atrophy.

Table I shows the usual time, following injury, that patients are able to commence walking without crutches or cane, with protected weight-bearing upon the injured limb:

TABLE I.—NUMBER OF DAYS FOLLOWING INJURY BEFORE PATIENT MAY RETURN TO WORK

	Days
Both bones of leg	21–28
Ankle joint—seen immediately following injury (before swelling)	1– 3
Ankle joint—seen after swelling has taken place—interval in pillow splint	5– 8
Os calcis—(reduction by hammering usually 3rd–8th day	10–16
Astragalus—(astragalectomy for crush fractures)	5–16
Mid-tarsal row—(cuneiforms, cuboid, and scaphoid)	5– 8
Tarsal bones	2– 8
Great toe	1– 8

It is unusual to find patients who are unwilling to co-operate. Nevertheless, it is frequently the case that a certain amount of education is required to induce the patient to commence weight-bearing. Among private patients objections are almost unknown and, the fact that business or professional men, or women, are able

to return to their offices without crutch or stick within 3 to 5 days of injury of foot or ankle, is usually greatly appreciated.

If a satisfactory brand of plaster of Paris be employed and the application of the plaster be carried out in accordance with the method advocated in this contribution, the apparatus is moderately durable. The length of time which it will last is dependent, of course, upon the weight of the individual, and the amount of walking he does. As a general rule, it is possible to apply a plaster which will be useful for from 6 to 12 weeks.

The chief objection to the technique recommended in this paper is that, with few exceptions, the patient must be admitted to hospital, or be so located that treatment can be carried out in his, or her, own home. Except for the occasional case which is seen prior to the development of swelling, bed rest, with suitable support and posture, must be available for a few days until all interstitial fluid in the affected limb has been dissipated. The absolute necessity of refraining from the application of unpadded plaster until all swelling has disappeared cannot be too strongly stressed. At this time, too, it may again be urged that weight-bearing should not be attempted upon a fractured limb encased in plaster applied over even a thin layer of padding.

It will be noted that there are but minor differences in the technique employed by Boehler and the author's method. As a matter of fact, except for the fact that padding beneath the foot has been eliminated by both, Dollinger's method forms the basis of both Boehler's method and my own. The steel stirrup employed by Boehler does not permit a boot to be worn, nor does it, I believe, protect the plaster more efficiently than the felt heel. Patients who have worn both appliances are unanimously in favor of the felt heel.

Apart, therefore, from the fact that it is our belief that earlier union occurs and, consequently, a shorter period need elapse before it is possible for the victim of a fracture to resume full duty with, we fully believe, a more perfect return of function, it is a matter of real importance that many citizens may be permitted, nay urged, to return to substantially full duty within but a few days of receipt of a fracture of ankle or foot, and within less than a month in the case of fractures of both bones of the leg.

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EDITORIALS

SURGERY
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JUNE, 1937

THE IMPORTANCE OF EARLY AND ACCURATE DIAGNOSIS IN OSTEOGENIC SARCOMA

OUR knowledge of osteogenic sarcoma and of its treatment has been so materially advanced by the Registry of Bone Sarcoma of the American College of Surgeons that we are now in a position to realize that early and adequate removal of the primary tumor offers the patient his only hope of survival. Generally speaking, treatment by radiation unaccompanied by amputation has not resulted in cure. All the 5 year survivals are patients who have been treated by amputation or resection or by amputation supplemented by radiation or by Coley's fluid. In the present state of our knowledge there is good ground for believing that radical removal of the primary tumor before metastases have occurred is the only practical means of curing the disease.

In order to be effective the removal of the tumor must be adequately radical. Since the majority of such tumors occur in the long bones of the extremities, this usually means disarticulation of the limb at the joint above the level of the tumor. Such treatment is sufficiently mutilating to arouse the greatest repugnance in the minds both of the surgeon and the patient or his parents; especially since the majority of the victims of this disease are adolescents or young adults. If this be the only effective form of treatment we must be sure of our ground lest our natural aversion to such mutilation lead to temporizing measures which deprive the patient of his only hope of survival. Fortunately, the facts to be learned from the Registry of Bone Sarcoma are definite and admit of only one interpretation: radiation, or any other treatment short of amputation offers only the remotest chance of cure; amputation, if successfully undertaken before metastases have occurred, can cure the disease. Though it is true that even after amputation the percentage of 5 year survivals is small (14 per cent), there is hope that more clear recognition of the radical nature of successful treatment will lead to earlier treatment which will be adequately radical and that this will be followed by a higher percentage of cures. The necessity of radical treatment as the only reasonably hopeful measure should be emphasized in order that there be no time lost in temporizing through more humane treatment.

To be successful even radical disarticulations must be undertaken early. The primary lesions must be removed before pulmonary metastases have occurred and since these occur early in the disease, amputation at the earliest moment is the only treatment which has any hope of success. This necessity places great

importance upon early and accurate recognition of the disease; early in order that treatment may have some hope of success and accurate in order that mutilating procedures may not be undertaken for lesions thought to be osteogenic sarcoma but which ultimately prove to be some more benign tumor.

In arriving at a diagnosis of osteogenic sarcoma four sources of information are available for us: history, physical examination, x-ray, and biopsy. History and physical examination unfortunately can do little more than indicate that some form of bone tumor is present. Nevertheless, such facts as the age of the patient, the bone involved, the situation of the tumor in the bone, whether the tumor is single or multiple, are of material importance in arriving at an accurate diagnosis.

The x-ray is by long odds the most important single clinical aid to diagnosis. By no other means can we obtain so clear a picture of the changes which are occurring in the bones. With good roentgenograms and skilled interpretation an accurate diagnosis can be made in most cases. Yet it should be remembered that what the x-ray shows is not the presence of osteogenic sarcoma but rather the changes which have occurred in the bone, the varying combinations of bone destruction and new bone formation. The conclusion that these are due to osteogenic sarcoma is a purely deductive one, and a high degree of accuracy in diagnosis is dependent upon long experience with such films. The typical picture is easily recognized. It should be clearly stated, however, that a definitely accurate diagnosis cannot always be made from x-rays and in atypical pictures it would be wiser to be content with the recognition of a malignant bone tumor and refrain from any attempt to state the exact type of tumor present.

Biopsy is the last resort and incomparably the most accurate means of diagnosis. So important is early and accurate diagnosis that we feel biopsy should be undertaken in all cases of bone tumor; certainly in all cases in which any doubt as to the diagnosis exists. In advocating this procedure we must recognize that pathologists, too, have their difficulties. The surgeon can minimize these by ensuring that he has a piece of tissue of adequate size and definitely of the tumor. For this reason diagnosis from puncture seems to have its shortcomings. It places too great a responsibility upon the pathologist to ask him to make a diagnosis involving a major disarticulation, from a few cells withdrawn in a needle.

We are aware of the objection which has been raised against biopsies; namely, that to perform a biopsy invites dissemination of the tumor and establishes the very metastases which it is desired to forestall. There may be truth in this though the available evidence, both clinical and experimental, is inconclusive. At any rate, this objection can be overcome in many cases by the use of a tourniquet above the level of the tumor. If this is high enough to occlude the nutrient vessels, and if it is left in place while the subsequent amputation is performed, the possibility of spread of the tumor as the result of the biopsy is small. The advantages are undoubtedly great. In at least 10 per cent of our cases it has been possible to prove by biopsy that a tumor thought to be osteogenic sarcoma actually was some other lesion and thus avoid an unnecessarily mutilating operation. At present our routine is to perform a biopsy on all cases of bone tumor. So far we have no cause to regret this policy and in many instances it has corrected an erroneous diagnosis and spared the patient much permanent disability.

There is some hope of further improvement in the treatment of osteogenic sarcoma if due recognition is given to the fact that cure can be obtained only by radical removal of the

primary growth before metastases have occurred. This statement requires bold emphasis and sincere recognition. Even this radical treatment is dependent upon early and accurate recognition of the tumor if it is to have any hope of success. In this connection biopsies are of great value. The danger of biopsy, if any exists, can be made a minimum by isolating the field with a tourniquet and planning the procedure so that amputation can be done under the same anesthetic if the pathologist confirms the clinical diagnosis. R. I. HARRIS.

SOME OBSERVATIONS ON ORTHOPEDIC SURGERY IN EUROPE

A FAIRLY extensive trip over Europe, with a glimpse into orthopedic clinics here and there, cannot but convince one that this specialty at least is growing steadily and becoming more and more important in most of the European countries.

With the meeting of the International Society of Orthopedic Surgery in Bologna a very good introduction to such a clinical tour was gained. The choice of Bologna was particularly fortunate, as it is the site of the Institute Rizzoli, one of the most complete orthopedic institutions in the world. Here, many developments of great importance in orthopedic surgery have been evolved since its establishment over one hundred years ago, and many orthopedic surgeons from all parts of the world have received instruction and stimulation from visits there. The presence of Professor Putti as president of the Congress added much to its success. He is one of the world leaders in orthopedic surgery and one of the founders of the International Orthopedic Society; he is an able surgeon and a man of great personal charm; the entire meeting centered around his presence and leadership.

Whether because of Putti's commanding influence or not, one could not help but gain the impression that orthopedic surgery in Italy has enjoyed very great progress. Those Italians who were on the program all had something of interest to say and were enthusiastic about their work. An outstanding example of this was found in a presentation by Faldini of Milan of an operative procedure for the treatment of fresh fractures of the neck of the femur. He proposed immediate osteotomy below the trochanter, with fixation of the hip operated upon in right-angled abduction for a period of several weeks. Proof of the efficacy of this treatment was furnished when he presented ten elderly women who had all been treated in this manner and who had all obtained excellent results. A high standard of excellence for papers before an international society was set by the author who presented his paper briefly in Italian, and then in English, French, and German.

In Professor Putti's inaugural address he pointed out that orthopedic surgery had long been regarded in Italy as the "surgery of the organs of movement." As such, Putti believed that the care of most traumatic conditions should come under the orthopedist's supervision. To this end the International Society of Orthopedic Surgery changed its name to the "International Society of Orthopedic Surgery and Traumatology."

Three distinct trends in the type of hospital organization for the care of orthopedic cases may be noted in the British Isles and in Continental Europe. First there are the old established general hospitals with orthopedic services. In some places the general surgeons have shown great reluctance to allow establishment of these services; but in the more progressive centers, such services have been built up and have reached a point of efficiency which insures their permanency. Many have

taken over at least in part the treatment of fractures, and such a division for the care of fractures seems to work to the advantage of all concerned. With this development of orthopedic services in general hospitals has gone a parallel development in out-patient services, including the establishment of physiotherapy departments which are more or less extensive in scope. In some instances these departments have reached a high standard of efficiency, not only in the treatment of patients, but in the development of schools of physical therapy.

The second type of hospital to be seen in England and Scotland, as well as on the Continent, is the orthopedic hospital which is devoted to the care of both children and adults with orthopedic conditions. Largely as a result of the impetus given this work by the late Sir Robert Jones, many such centers have been established in the British Isles. In these hospitals may be found all sorts of orthopedic patients, both adults and children, who are well cared for by competent staffs, orthopedic as well as nursing. What is perhaps more important than the hospitals themselves is the organization of central and subsidiary clinics which look after the collection of cases for the hospitals and follow the patients along in their after-care so long as necessary. These clinics are well organized both as to medical and social services and they insure an almost constant contact with orthopedic patients for the many years that are necessary for their adequate care. In England this work has been carried on by private philanthropic societies and committees. While many patients are aided in paying for their hospital care by county and state funds, the organizations themselves run and control the hospitals and clinics too. The same type of organization may be found in Denmark, and a new hospital of this type is in operation in Copenhagen. There were similar hospitals in Sweden and Czechoslovakia. Most of these hospitals are very complete units so far as care of the crippled is concerned. They not only have complete hospital units, with all the necessary operating rooms and physiotherapy equipment, including in many instances pools for the treatment of patients with infantile paralysis, but also schools, often vocational as well as grammar, and complete brace shops and factories for making artificial limbs. Such complete units can be found in nearly all of the countries of Europe.

The third type of hospital is best exemplified in the clinic of Professor Boehler in Vienna which is a hospital built by an insurance company or several insurance companies for the handling of insurance cases. Because of the excellence of Boehler's work and the world-wide reputation he has established in the care of fractures, it is only natural that others should attempt to follow his example in every detail, and there are accordingly other hospitals like his which are well run and well organized. How far such institutions might go in a country as large as ours is difficult to guess.

Thus there are in Europe today three different trends in the manner of handling orthopedic cases. Each type of institution, when backed by an efficient and progressive staff, is doing excellent work, and it would be difficult to say which type might assume greater leadership in the development of orthopedic surgery during the next fifty years.

RALPH K. GHORMLEY

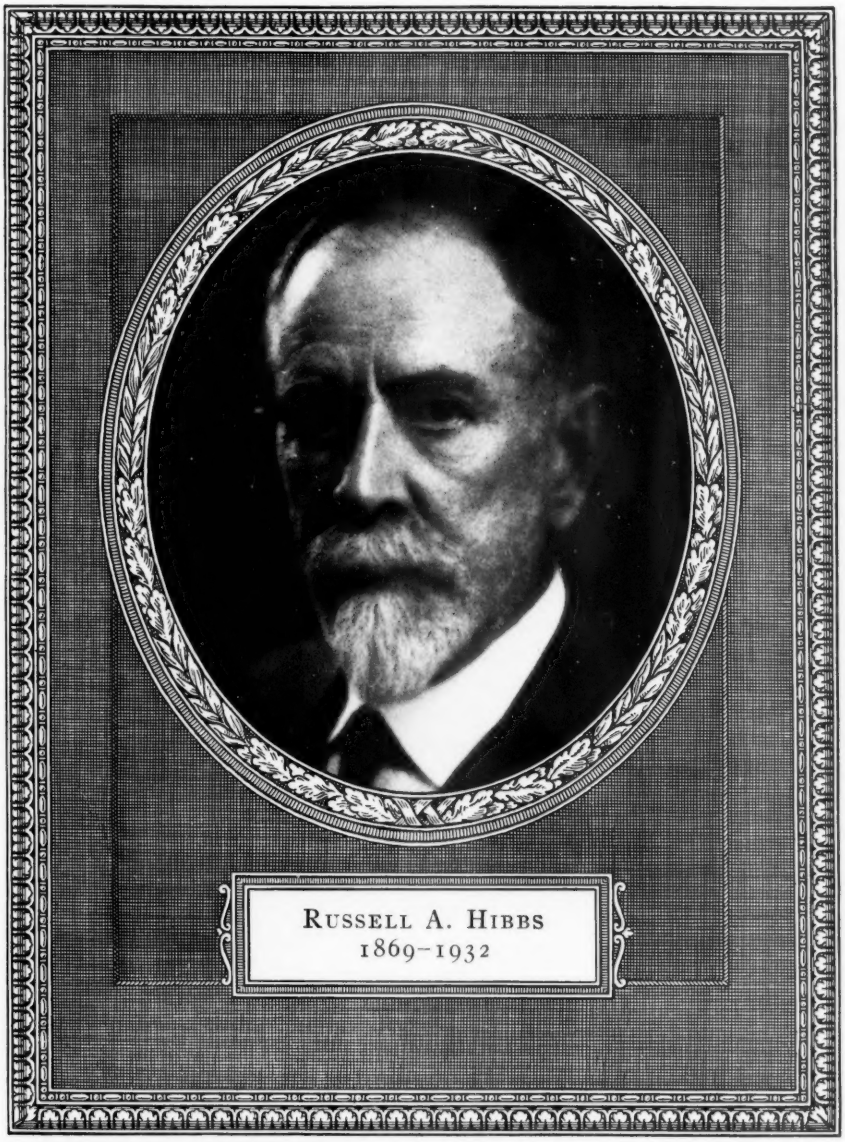
MASTER SURGEONS OF AMERICA

RUSSELL A. HIBBS

RUSSELL A. HIBBS was one of the outstanding surgeons of his era and his contributions to orthopedic surgery mark him as one of the foremost in that specialty since its beginning. Unprejudiced by the generally accepted views and practices of his time, he slowly and carefully formed his own opinions from personal observations and, once having made up his mind that he was right, he persevered in that course in spite of all opposition until he finally convinced his critics. This attitude, combined with a great originality and ingenuity in devising new operations and methods of treatment, made his influence, more than that of any other, responsible for transforming orthopedics into a real part of surgery during the last thirty years.

Although he wrote on almost all subjects pertaining to his specialty, his most conspicuous work was on joint tuberculosis and it was this which first gave him a world-wide reputation. His efforts have effected a complete revolution in the treatment of this condition and have made it possible by surgery to effect a rapid cure and to save its victims from a life of invalidism. Early in his career he realized that the results obtained by the generally accepted methods of treatment were unsatisfactory. He decided that this was due to lack of fresh air and sunlight and the poor surroundings in which the majority of the dispensary patients lived. His appeal for something better resulted in building a country branch for the New York Orthopædic Dispensary and Hospital, of which he was the surgeon-in-chief. The building of this institution had an important influence in making him seek other means for curing the disease, for it proved to him that even under the best obtainable conditions the conservative measures, such as the application of braces and the use of heliotherapy, were a failure.

Dr. Hibbs' observation that the only cases of tuberculosis of the spine that really were cured by conservative treatment were those in which a natural fusion was secured led him in 1911 to devise the spine fusion operation, perhaps his greatest single achievement. At first it consisted simply in breaking down the spinous processes and causing them to grow together, but soon the technique was perfected and included the fusion of the laminæ and lateral articulations as well. Not only was it a brilliant success in the treatment of Pott's disease but its application to lateral curvature, fractures, and various anomalies of the spine has changed entirely the treatment of those conditions. The development, after many painstaking efforts, of a successful method for the correction of scoliosis,



RUSSELL A. HIBBS
1869–1932

and the maintenance of that correction by the fusion operation constitute another brilliant chapter to which he contributed in the history of orthopedic surgery.

In 1909 Dr. Hibbs devised an operation for stiffening the knee joint which could be used for children without interfering with the growth of the extremity. It originally was intended for stabilizing flail joints in cases of poliomyelitis and is used extensively for that purpose. It soon was used also as a means of curing tuberculosis of the knee, and has done the same thing for that lesion that the spine fusion operation has done for Pott's disease. An operation for arthrodesis of the ankle followed.

It was generally conceded that of all tuberculous joints the hip was the most serious and that the results were universally bad. Although it was realized that the same principles applied here as in the other joints and that fusion would solve the difficulty, a method for accomplishing this was sought in vain. Finally, in 1926 Dr. Hibbs invented the operation of transplanting the greater trochanter and using it as a bridge from the femur to the ilium. This completed a monumental work, for this operation made it possible to cope with tuberculosis of all the joints.

Much of the misunderstanding about joint tuberculosis and the failure of others to comprehend the inadequacy of the older methods in dealing with it, were due to the gross errors in diagnosis which resulted from reliance upon clinical and x-ray examinations. Dr. Hibbs' insistence upon the use of more exact methods, including exploratory operation and biopsy, demonstrated how widespread the mistakes had been and that many of the cases that had been regarded as cures had not been tuberculosis at all. His careful follow-up studies of his tuberculous patients for long periods of time, and his refusal to accept as a cure any case that had not been thus studied, showed that many of the so called cures had relapses after several years.

An essay on the management of the proximal fragment in cases of fracture of the upper third of the femoral shaft, which won a prize, and a new operation for lengthening the tendo achillis, both produced early in his career, are other evidences of his originality and resourcefulness.

His many contributions to surgery, almost any one of which would have been sufficient to bring him fame, represent only one phase of his remarkable achievements. His great ability as an organizer and administrator is shown in the development of the New York Orthopædic Dispensary and Hospital, of which he was made surgeon-in-chief in 1899. At that time it was a small hospital occupying a remodelled dwelling house. Under his direction, and as a result of his enthusiasm, it has now grown to a large, splendidly equipped institution with a bed capacity of three hundred, including a beautiful country branch at White Plains for the convalescent care of these patients. In 1904 Dr. Hibbs founded

the New Jersey Orthopædic Hospital and for years thereafter was its consulting surgeon and guiding spirit. It is now a finely equipped hospital with an affiliated convalescent home, in which is done the same type of surgery as in the New York Orthopædic Hospital.

Another of his chief interests was medical education and the development of young men. In 1918 he was appointed professor of orthopedic surgery in the College of Physicians and Surgeons, Columbia University, a post which he held until a few months before his death. His lectures were always among the most popular in the curriculum and caused his students to take a keen interest in the subject. His concern for the better training of young surgeons after they had finished their interneship led to the establishment of the Annie C. Kane fellowships at the New York Orthopædic Hospital. They make provision for the continued training of a selected group of these men at the hospital for several years at an adequate salary. It was Dr. Hibbs' hope that this example might lead to similar fellowships in other fields of medicine and surgery. His greatest delight was in the success and achievements of the young men who had gone through this hospital and the occasion of their return to an annual meeting at the hospital was to him the great event of each year. His devotion to children was further exemplified by his deep interest in Hope Farm, a community home, of which he was president for many years.

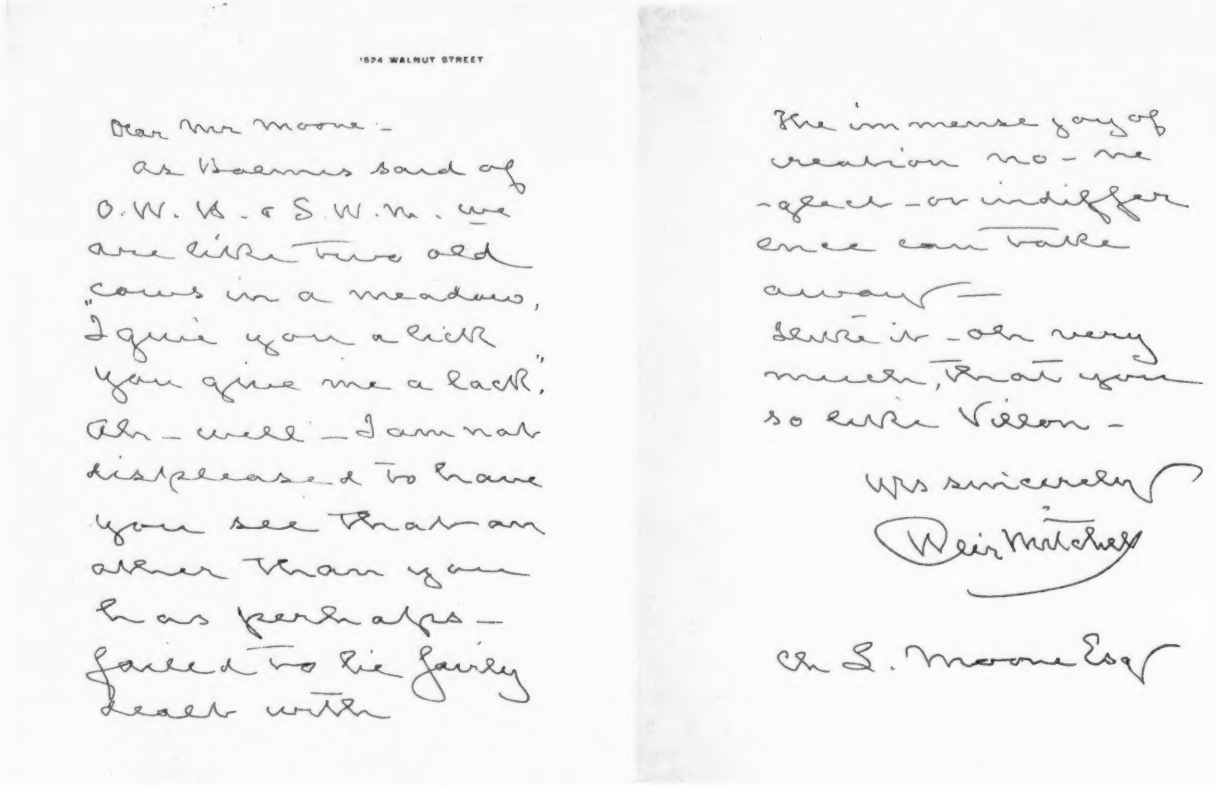
To those who knew him best his greatness lay even more in his fine spiritual qualities, in his never failing conviction that the truth must always prevail, in his steadfast adherence to any course that he believed was right, and in that rare gift of leadership which inspired all those who served under him to give the best that was in them and to feel that to work with him was a privilege. He always maintained that any accomplishment that was made in the advancement of medicine must come from a deep sympathy of the doctor for his patient and from his real concern in making him well.

Dr. Hibbs was born in Birdsville, Kentucky, on September 1, 1869. He attended Vanderbilt University and received his medical degree from the University of Louisville in 1890. After practicing for several years as a country doctor in a remote part of Texas, he went to New York in 1893, determined to prepare himself better for his work. He was an interne for one year at the Polyclinic Hospital and then became resident surgeon at the New York Orthopædic Dispensary and Hospital. When he had served in that capacity for 6 years he was made surgeon-in-chief in 1899, at the age of 30, and was still in active charge of the hospital at the time of his death, September 16, 1932. He also was consulting surgeon to the Presbyterian, Babies', French, Sea View, and Beekman Street Hospitals, the Neurological Institute, the New York Infirmary for Women and Children, and St. John's Riverside Hospital, Yonkers. He was a member of the American Orthopedic Association, the Interurban Orthopedic, and Union

Clubs, the Practitioners' Society, and a fellow of the American Medical Association, the American College of Surgeons, and the New York Academy of Medicine. During the World War Dr. Hibbs was a major in the Medical Corps of the Army and a consultant at the Walter Reed Hospital.

On September 1, 1904, Doctor Hibbs married Miss Madeline Cutting, who was the daughter of the late Walter Cutting, at Pittsfield, Massachusetts.

ALAN DEF. SMITH.



1524 WALNUT STREET

Dear Mr Moore –

As Boswell said of O. W. H. & S. W. M. "we are like two old cows in a meadow, I give you a lick, you give me a lick", Ah – well – I am not displeased to have you see that an other than you has perhaps – failed to be fairly dealt with

the immense joy of creation no – no – glee – or indifference can take away –

Like it – oh very much, that you so like Villon –

Yrs sincerely

Weir Mitchell

Chas L. Moore Esq

Facsimile of a letter from Dr. S. Weir Mitchell (1830-1914) of Philadelphia, poet and physician, whose description of "Causalgia" remains a classic in medical literature.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE revision of the popular volume[1] by Holmes and Ruggles brings the subject of roentgen interpretation up to date. The work covers the field of roentgen diagnosis and includes an adequate bibliography at the end of each chapter. The illustrations show for the most part typical lesions. There has been some rearrangement of these illustrations and in some instances a replacement of those found in the previous editions by better reproductions. The 243 engravings are made up largely of excellent reproductions of roentgenograms.

The chapter on bone pathology has been completely revised and now includes material dealing with bone changes associated with various deficiency diseases and glandular dysfunction as well as the more rare conditions, such as renal rickets, lead poisoning, Gaucher's disease, and marble bone.

In the chapter on chest the authors have added material on calcification within the heart, Ayerza's disease, myxedema, Baeck's sarcoid, and psittacosis.

A discussion on rugal fold studies, hepatolienography findings in diaphragmatic hernia, steatorrhea, sprue, and regional ileitis has been included in the chapter on the gastro-intestinal tract. The sections on cholecystography, intravenous urography, renal anomalies, pelvic and fetal measurements have been revised and enlarged.

The subject material is presented in a concise manner but covers the field of roentgen diagnosis adequately. The volume has long since established itself as an excellent textbook for undergraduates and should be very helpful to the medical practitioner. It is recommended without reservation.

EARL E. BARTH.

ALL the diseases of the testicle as well as the anomalies are treated by Bailey in his complete monograph[2]. The epididymis and coverings of the testicle are also included.

This small compact volume is profusely illustrated and contains several excellent colored plates. The paper is of the best quality, and the book has an unusual cloth cover, seldom seen in standard medical books.

The subject matter is expertly handled; each chapter is concluded with the references applicable to the subject, which makes easy and pleasant reading.

Functional diseases and the subject of rejuvenation are briefly and thoroughly handled. Dr. Bailey concludes with, "True progress (in rejuvenation) has been retarded by extravagant claims and publicity in the lay press."

The library of any surgeon or urologist is not complete without this fine work. L. L. VESEEN.

SINCE the publication of the second edition of Cabot's *Modern Urology*,[3] generally approved and recognized in 1924, there have not only been many changes of thought in the therapeutic and surgical management of various diseases of the genito-urinary tract, but likewise many epoch making additions heretofore never thought of or only lightly touched. Outstanding progress in diagnostic procedures has been made as well as important additions and changes of opinion of etiology.

This third edition has been so thoroughly revised to include the many advances made in this specialty that it is essentially a new work. Obviously many new authors are added and the works of other authors changed in keeping with their special experience and recognized ability at this date.

The thoroughness with which this field is covered is indicated by the fact that it totals 1813 pages, illustrated with 920 engravings and 21 plates. One is impressed by the lack of repetition, the completeness of each subject discussed and the extensiveness of the bibliography. Many chapters are, in fact, monographs and include historical data together with the latest recognized views on the subject.

The technique of surgical procedures is discussed in the minutest detail accompanied by step by step illustrations which should be readily understood.

This is a thorough, comprehensive work, modern to the last minute, produced by authors who speak with authority on their particular subjects, which facts make it a valuable asset not only for urologists but for general surgeons, internists, and general practitioners as well. As a reference work for medical students, working on special subjects, it has been found invaluable. HARRY CULVER.

AN EXCELLENT analysis of current thought for and against the use of digitalis in the various problems associated with heart disorders is made by Luten in his recent monograph[4]. The book is well organized, clearly printed, carefully bound, and accurately indexed. The author presents the viewpoints pro and con of many investigators and

[1] ROENTGEN INTERPRETATION; A MANUAL FOR STUDENTS AND PRACTITIONERS. By George W. Holmes, M.D., and Howard E. Ruggles, M.D. 5th rev. ed. Philadelphia: Lea & Febiger, 1936.

[2] DISEASES OF THE TESTICLE. By Hamilton Bailey, F.R.C.S. (Eng.). London: H. K. Lewis & Co. Ltd., 1936.

[3] MODERN UROLOGY. In Original Contributions by American Authors. Edited by Hugh Cabot, M.D., LL.D., C.M.G., F.A.C.S. Vols. 1 and 2. 3d rev. ed. Philadelphia: Lea & Febiger, 1936.

[4] THE CLINICAL USE OF DIGITALIS. By Drew Luten, A.B., M.D. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1936.

critically analyzes their studies of the value of digitalis.

There is an excellent discussion of indications and methods of dosage and the author advises oral administration as most preferable. The toxic effects are carefully discussed and a plea is made that the physician should be equally cautious in observing the patient for the optimum results and toxic manifestations as in choosing his indications.

The pharmacological action of digitalis is discussed in detail. He points out that "the therapeutic efficacy of digitalis results from the action of the drug upon ventricular muscle," and furthermore that "tachycardia *per se* is not an indication for digitalis." Pneumonia, shock, septicemia, angina pectoris, and many toxic states associated with tachycardia are not indications for the use of digitalis.

The text will be of practical value to the practitioner, the specialist, and the medical student.

CHAUNCEY C. MAHER.

THE lengthy and detailed volume on urology by Lowsley and Kirwin[1] is unquestionably the best of its kind to date. The reviewer has attempted to teach nurses the rudiments of urological nursing for several years and has felt the lack of a complete work of this kind. There are some good books on this subject but none of them go into the minute detail found here.

The authors give full credit to the entire nursing staff of the department of urology of the (James Buchanan Foundation) New York Hospital.

The volume is profusely illustrated with clear photographs, drawings, charts, and cuts of various instruments. The history of urology is briefly given, followed by the public health aspect of tuberculosis and venereal diseases. This is followed by the technical procedures peculiar to urology, then the care of instruments, which is an important matter as many urologists can testify. A review of embryology accompanies the management of the many diseases and malformations of the genito-urinary tract. Surgical technique is detailed as is also nurses' set-up and the postoperative care. After an excellent chapter on diets the authors conclude with a comprehensive glossary of urological terms.

It would well profit the interne and resident as well as the urological nurse to study this book for its practical value. The authors have well attained their aim and purpose as expressed in the preface.

L. L. VESEEN.

AVERY elaborate clinical and histopathologic study of a large number of cases of Paget's disease and related conditions is the basis for Inglis's monograph[2] entitled *Paget's Disease of the Nipple.* The observations are presented extensively in case reports and are well illustrated by excellent gross pathological and histological photographs. On the basis of this material, the author formulates his opinion in the long controversy concerning the histogenesis and the clinical importance of Paget's disease of the nipple as follows.

He considers Paget's disease as a special variety of cancer of the mammary ducts. It is a surface cancer beginning at the junction of lactiferous duct with epidermis or in a lactiferous duct near its outlet. It is neoplastic from the outset. From its site of origin the growth, without forming any definite nodules, extends by continuous spread downward in the epithelium lining of the duct wall to the acini and outward in the epidermis of the nipple. The duct lesion and the skin lesion represent the same stage in the one pathological process. The disease may remain limited to the epidermis and the ducts for many years, but usually within a few years scirrhous cancer forms in the substance of the breast.

The author discusses separately the clinical and histological picture of Paget's disease caused by this series of pathological changes. He includes Paget's disease uncomplicated by scirrhous carcinoma, Paget's disease complicated by scirrhous carcinoma, and Paget's disease in which the presence of scirrhous carcinoma is doubtful.

Following the clinical and histological discussion of these different types of Paget's disease of the nipple, the author discusses the histological appearance of conditions which may be confused clinically with Paget's disease, as cancerous infiltrations of the nipple by deep-seated cancer of the breast or eczema and dermatitis of the nipple or areola simulating Paget's disease.

After a short discussion of other primary diseases of the nipple, as connective tissue and epithelial tumors, he devotes some chapters to lesions of squamous cell epithelial structures which may show changes in the squamous epithelium similar to those observed in the skin epithelium of Paget's disease. He includes here Paget's disease of other parts of the body, Bowen's precancerous dermatoses and precancerous changes in the epithelium of the upper alimentary tract, the vulva, the cervix uteri, and the glans penis. He demonstrates the principal difference in the histologic and histogenetic characteristics of these lesions as compared to Paget's disease of the nipple insofar as all these lesions originate from cancerous changes of the epithelial cells *in situ*, whereas in Paget's disease he considers the cancerous cells as having invaded the epithelium of the overlying skin.

It is obvious from this review that the author is not in agreement with some other authorities in this field, as for instance Cheatle, regarding the histogenesis and the mode of growth in Paget's disease of the nipple. He does, however, agree with the more practical consequence in regard to the almost universally accepted opinion that Paget's disease should

[1] UROLOGY: FOR NURSES. By Oswald Swinney Lowsley, M.D., F.A.C.S., and Thomas Joseph Kirwin, M.D., F.A.C.S. Philadelphia, London, Montreal: J. B. Lippincott Co., 1936.

[2] OXFORD MEDICAL PUBLICATIONS. PAGET'S DISEASE OF THE NIPPLE: AND ITS RELATION TO SURFACE CANCERS AND PRECANCEROUS STATES IN GENERAL. By Keith Inglis, M.D., Ch.M. (Sydney). London: Oxford University Press, 1936.

be considered from the beginning as a true cancerous lesion and should be treated as a breast cancer.

This volume represents a most valuable archive of detailed clinical reports and beautiful histologic pictures of Paget's disease and related conditions. The careful interpretation of the material on which this study is based together with the exhaustive discussion of the literature gives it its proper place in the vast amount of material already available in this much discussed field. MAX CUTLER.

IN THE preface of their book[1] entitled *Obstetric Management and Nursing*, Woodward and Gardner state clearly their purpose: "First to supply the student with what she should know about obstetrical nursing; second, to add to her general knowledge pertaining to obstetrical management, the part the obstetrician plays and her duties in assisting him in an intelligent manner; third, to provide for the needs of the student who would specialize as an obstetrical nurse or become a supervisor of obstetrics."

The book contains several helpful and interesting parts, such as the unit on "The Background of Obstetrical Nursing" and the chapter on "Mental Hygiene of the Pregnant Woman." The subject naturally falls into certain units and this method of organization is very skillfully used here. Each unit is divided into chapters. The units are preceded by a glossary in alphabetical order with the pronunciation of each word following, and then the definition. Each chapter contains a brief outline of the material presented. Each part of the chapter has a summary and at the end is given a "Continued Study Units" that contains further study references, then a list of questions on the subject matter that has been presented in that chapter. One feature of the questions is that some of them are not specifically answered in the text. The last presentation is a "Correlations for Next Chapter."

The chapters on the abnormalities of pregnancy, labor, and the newborn are given after the student has gained a good knowledge of a normal pregnancy and labor. This should be most helpful to the student because in presenting it in this way there should be no confusion of the two. The chapters, illustrations, and drawings throughout the book are numerous and well chosen. The drawing on fetal circulation is particularly good.

The instructor of obstetrical nursing should find this book most useful. It presents the material in a clear, logical, and interesting manner and could be used either as a text or reference book.

LORNA ROBINSON, R.N.

THE new textbook[2] of medicine by the well known physician, Jonathan Meakins, of McGill University, departs considerably from the standard textbook by Dr. Osler. The subject matter is rearranged so that the diseases of the upper respiratory tract appear first and in a systematic order. Chapter 5 on the "Diseases of the Lungs" is especially well treated as might be expected from one who has done so much with the respiratory system as has Dr. Meakins. The extreme importance of continuous oxygen therapy and caution of respiratory depression of drugs such as morphine in pneumonia is brought out with emphasis. Similar evidences of a truly modern text are shown by the discussion of the basic principles in the section on vascular disease where helium therapy may be applied. Coronary occlusion, though not featured, is discussed in more detail than in similar texts, which the reviewer has always felt is a serious neglect of an important topic.

The section on hypertension is stated in a concise manner. Electrocardiograms and numerous photomicrographs add materially to this chapter. Diseases of the urinary system have been discussed well to the back of the book which section is written by Walter de M. Scriver. The subject matter is well arranged, but not enough space has been allotted to develop the subject adequately. The same criticism may be applied to many topics of this volume, as to all other texts of this type.

A moderate number of good references appear at the end of each chapter. The chief step forward in Dr. Meakins' book is the large number of colored plates, graphs, and photomicrographs which follow the present trend toward visual education.

M. HERBERT BARKER.

THE subject matter of Browne of Dublin's *A Manual of Practical Obstetrics*[3] is arranged in the conventional manner. The reviewer kept in mind at all times that this volume was written in Dublin, and as the author expressed, "it was written chiefly for students and the general practitioner," presumably in Ireland. He further explained that "the text is the expression of the experience gained both in actual practice and whilst teaching students and post-graduates."

While the keynote of this manual denotes conservatism in the management of pregnancy and labor, it is apparent that many of the methods used in Dublin are unusual and do not quite meet our idea of conservative obstetrics. The unconcern with which the problem of occiputoposterior positions is treated is such an example. The book might have a place in the American obstetrician's library as a reference, but it can hardly be recommended as a text for general use in this country.

C. C. DOHERTY.

A NUMBER of well known authors in the field of heart disease contributed to the comprehensive survey of the modern concepts of diseases of the coronary arteries and cardiac pain and the text[4] was

[1] OBSTETRIC MANAGEMENT AND NURSING. By Henry L. Woodward, M.D., and Bernice Gardner, R.N. Philadelphia: F. A. Davis Co., 1936.
[2] THE PRACTICE OF MEDICINE. By Jonathan Campbell Meakins, M.D., LL.D. St. Louis: C. V. Mosby Co., 1936.
[3] A MANUAL OF PRACTICAL OBSTETRICS. By O'Donel Browne, M.B., B.Ch., B.A.O., F.R.C.P.I., L.M., M.C.O.G. Baltimore: William Wood & Co., 1936.
[4] DISEASES OF THE CORONARY ARTERIES AND CARDIAC PAIN. Edited by Robert L. Levy, M.D. New York: The Macmillan Co., 1936.

edited by Dr. Levy. The book is splendidly printed, well bound, fully indexed, and includes an extensive bibliography of both historical and modern references of the subject.

Dr. Alfred E. Cohn, in the introduction, rationally outlines the subject matter and discusses many of the current unsolved problems. Dr. James B. Herrick follows with an excellent historical note.

The anatomy and physiology of the coronary circulation is discussed by Dr. Joseph T. Wearn and Dr. Carl J. Wiggers, respectively. The latter subject is discussed in considerable technical detail and many controversial issues are fully covered. The effects of the nitrites, theobromine, digitalis, glucose and insulin, epinephrine and pituitrin upon the coronary circulation are briefly discussed by Dr. Fred M. Smith. Dr. William C. Von Glahn covered the histologic findings of the coronary arteries in infectious diseases, periarteritis nodosa, rheumatic fever, syphilis, tuberculosis, and arteriosclerosis, but mention is not made of the histologic changes associated with acute occlusion. The nervous pathways and the physiology of the coronary arteries are described by Dr. James C. White and Dr. Carl J. Wiggers.

An exceptionally interesting chapter of statistical information by Louis I. Dublin of the Metropolitan Life Insurance Company is included.

The editor, Dr. Levy, covers the clinical aspects of the subject and also syphilis of the coronary arteries as well as treatment. Dr. William J. Kerr was assigned the subject of involvement of the coronary system by embolism, periarteritis nodosa, aneurism, and rheumatism. Dr. Paul D. White's discussion of the clinical significance of cardiac pain is a particularly practical discussion, colored by his broad experience. Electrocardiographic diagnosis is discussed by Dr. Frank N. Wilson and is well illustrated by many typical electrocardiograms.

Surgical treatment of pain and paravertebral injection of alcohol are discussed by Dr. James C. White. Dr. Herman N. Blumgart presents his brief for the relief of cardiac pain and congestive heart failure by total thyroidectomy, a method not as universally acceptable as he indicates. Dr. Claude S. Beck very briefly discusses his work in the development of a new blood supply by operation.

The editor is to be commended on the selection of his co-authors. The inclusion of a roentgenologist might have been considered advisable and perhaps a chemical consideration of the problem. The frequent relationship of other diseases is mentioned by many of the authors and somewhat briefly dismissed. The book deserves an excellent recommendation for presenting the modern concepts of the subject.

C. C. MAHER.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

DR. BETTERMAN'S DIARY FOR THE YEARS 1868, 1873, 1893, 1909, 1910. Collated from the Old Doctor's journals and edited by Charles Elton Blanchard, M.D. Youngstown, Ohio: Medical Success Press, 1937.

MARRIAGE AND PERIODIC ABSTINENCE; THE NATURAL METHOD OF SCIENTIFIC FAMILY REGULATION. By J. G. H. Holt, M.D. London, New York, and Toronto: Longmans, Green and Co., 1937.

THE LITTLE THINGS IN LIFE; THE VITAMINS, HORMONES, AND OTHER MINUTE ESSENTIALS FOR HEALTH. By Barnett Sure, Ph.D. New York and London: D. Appleton-Century Co., 1937.

VEIT'S HANDBUCH DER GYNAEKOLOGIE. Edited by W. Stoeckel. Vol. II—DIE BEZIEHUNGEN DES NERVENSYSTEMS ZU DEN NORMALEN BETRIEBSABLAEUFEN UND ZU DEN FUNKTIONELLEN STOERUNGEN IM WEIBLICHEN GENITALE. By Dr. Max Walthard. Munich: J. F. Bergmann, 1937.

SEXUAL POWER. By Chester Tilton Stone, M.D. New York and London: D. Appleton-Century Co., 1937.

TRANSACTIONS OF THE AMERICAN GYNECOLOGICAL SOCIETY. Vol. 61 for the year 1936. Edited by Otto H. Schwarz, M.D. St. Louis: The C. V. Mosby Co., 1937.

OXFORD MEDICAL PUBLICATIONS. HIGH BLOOD PRESSURE. By I. Harris, M.D. London: Oxford University Press, 1937.

OXFORD MEDICAL PUBLICATIONS. PHYSIOLOGY AND PATHOLOGY OF THE HEART AND BLOOD-VESSELS. By John Plesch, M.D. (Budapest), M.D. (Germany), L.R.C.P. London: Oxford University Press, 1937.

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

EUGENE H. POOL, New York, *President* FREDERIC A. BESLEY, Waukegan, *President-Elect*
VERNON C. DAVID, *Chairman;* MICHAEL L. MASON, *Secretary, Committee on Arrangements*

PLANS FOR THE 1937 CLINICAL CONGRESS IN CHICAGO

UNDER the leadership of a strong and representative committee, the surgeons of Chicago are planning to provide a program of surgical clinics and demonstrations that will present a complete showing of clinical activities in all departments of surgery in this great medical center during the twenty-seventh annual Clinical Congress of the American College of Surgeons, October 25–29.

The Executive Committee in charge of arrangements is as follows:

VERNON C. DAVID, *Chairman*
MICHAEL L. MASON, *Secretary*
FRED L. ADAIR
RALPH B. BETTMAN
ALEXANDER BRUNSCHWIG
FREDERICK CHRISTOPHER
WARREN H. COLE
EDWARD L. COMPERE
JOHN S. COULTER
WILLIAM R. CUBBINS
HARRY CULVER
LOYAL DAVIS
GEORGE DETARNOWSKY
LESTER R. DRAGSTEDT
HARRY S. GRADLE
M. J. HUBENY
SELIM W. MCARTHUR
KARL A. MEYER
A. H. MONTGOMERY
OSCAR E. NADEAU
DALLAS B. PHEMISTER
SAMUEL SALINGER
C. F. SAWYER

The Committee is assured of the hearty co-operation of the clinicians at the five medical schools and more than fifty hospitals that will participate in the clinical program.

In addition to providing an ample and well arranged schedule of operative clinics demonstrating the technique of a wide variety of surgical procedures, the Committee plans to arrange a series of demonstration clinics at the medical schools and in the larger hospitals for the presentation of work being done in neurosurgery, traumatic surgery, thoracic surgery, fractures, plastic surgery, cancer, orthopedics, genito-urinary surgery, obstetrics and gynecology, physical therapy, roentgenology, etc. The programs will be so correlated that the visiting surgeon may be assured an opportunity to devote his time continuously, if he wishes, to clinics dealing particularly with the special subjects in which he is most interested. Thus, for example, it is planned to arrange so that fracture clinics will be available each forenoon and afternoon during the Congress; and similarly clinics and demonstrations in many special subjects.

A preliminary schedule of operative clinics and demonstrations is being prepared by the Committee for publication in the July issue of SURGERY, GYNECOLOGY AND OBSTETRICS. Clinics will be arranged for the afternoon of Monday, October 25, and for the mornings and afternoons of each of the four following days. All departments of surgery will be represented therein.

The Executive Committee of the Board of Regents is preparing programs for the scientific sessions to be held each evening in the ballroom of the Stevens Hotel. At the opening session on Monday evening the retiring president, Dr. Eugene H. Pool, of New York, will deliver the presidential address and the new officers—Dr. Frederic A. Besley, of Waukegan, president; Dr. Frank W. Lynch, of San Francisco, and Dr. Austin B. Schinbein, of Vancouver, vice-presidents—will be inaugurated. The 1937 class of initiates will be received into Fellowship at this session. On Tuesday, Wednesday and Thursday evenings eminent surgeons of the United States and Canada, together with a number of visiting surgeons from foreign countries, will present and discuss papers dealing with surgical subjects of timely importance.

In addition to an extensive schedule of operative clinics and demonstrations at the hospitals prepared by the sub-committees on ophthalmology and otolaryngology, it is planned to arrange for two evening sessions at the Stevens Hotel at which visiting ophthalmologists and otolaryngologists will present and discuss papers of special interest.

Other features of this year's Congress include conferences and symposia dealing with fractures, cancer, obstetrics and gynecology, industrial medicine and traumatic surgery.

As they so faithfully depict clinical features of major interest to surgeons, the showing of surgical motion picture films will be continued at this year's session with an enlarged program of both

sound and silent pictures to be exhibited daily at headquarters.

The annual hospital conference will open the Congress with a session in the ballroom of the Stevens Hotel at 10 o'clock on Monday morning. An interesting program of papers, round table conferences and practical demonstrations dealing with problems related to hospital efficiency is being prepared for sessions on Monday, Tuesday, Wednesday and Thursday. It is proposed to make this year's session of wide interest and practical character through a careful selection of subjects to be presented and discussed by surgeons and hospital executives. Particular emphasis will be directed toward professional standards and the vital problems related to hospital economies.

Headquarters for the Congress will be established at the Stevens Hotel where the grand ballroom with its large foyers and other meeting-rooms on the second and third floors have been reserved for scientific sessions and conferences.

The Technical Exhibition will be located in the Exhibition Hall in which will be placed the registration and clinic ticket bureaus and the bulletin boards on which the daily clinical program will be posted each afternoon for the following day. Leading manufacturers of surgical instruments, x-ray apparatus, operating room lights, hospital apparatus and supplies of all kinds, ligatures, dressings, pharmaceuticals and publishers of medical books will be represented.

The hospitals and medical schools of Chicago afford accommodations for a large number of visiting surgeons, but to insure against overcrowding, attendance at the Congress will be limited to a number that can be comfortably accommodated at the clinics, the limit of attendance being based upon the result of a survey of the amphitheaters, operating rooms, and laboratories of the hospitals and medical schools to determine their capacity for visitors. It is expected, therefore, that those surgeons who wish to attend the Congress will register in advance.

A registration fee of $5.00 is required of each surgeon attending the annual Clinical Congress, such fees providing the funds with which to meet the expenses of the meeting. To each surgeon registering in advance a formal receipt for the registration fee is issued, which receipt is to be exchanged for a general admission card upon his registration at headquarters. This card, which is non-transferable, must be presented in order to secure clinic tickets and admission to the evening meetings.

Admittance to clinics and demonstrations will be controlled by means of special clinic tickets, such plan providing an efficient means for the distribution of the visiting surgeons among the several clinics and insuring against overcrowding, as the number of tickets issued for any clinic will be limited to the capacity of the room in which that clinic is given.